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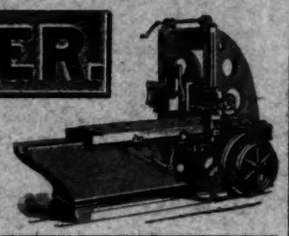

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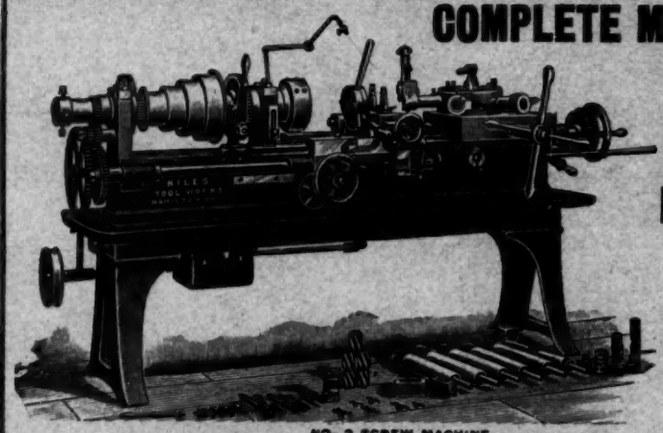

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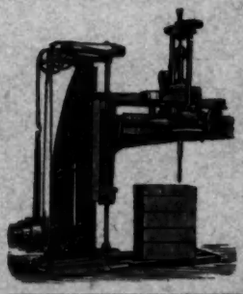

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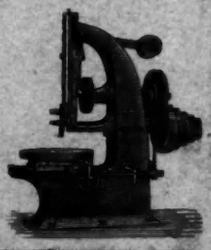

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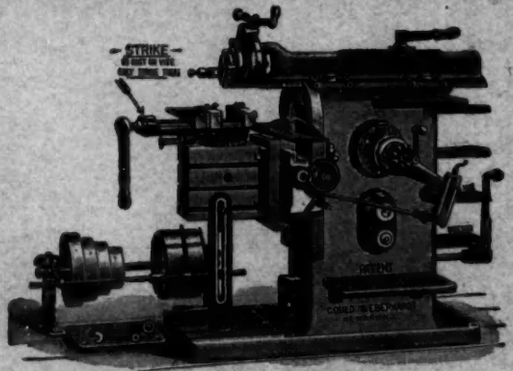

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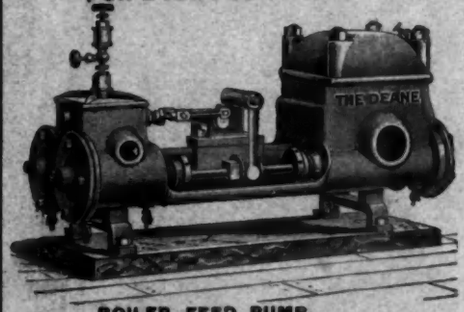

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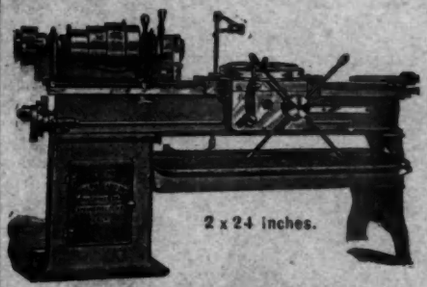

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Punch and Die Work—Rotary Files—Truing Work.

BY A. H. CLEAVES.

Let us suppose it desirable to use a lot of machine screws for thumb screws, as shown in Fig. 2, *B* being the screw and *A* the punching used for thumb piece or handle.

Taking this piece *A*, Fig. 2, merely as

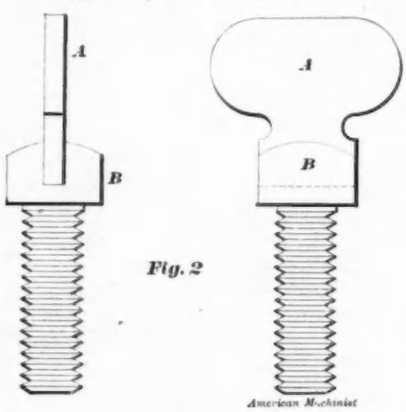


Fig. 2

a sample, and letting it represent a class of work in which the two opposite halves separated by the center line are required to be exactly alike; then a simple and effective method for getting such a result may be found by a study of Fig. 1.

First have a stock of thin, smooth sheet steel of good quality on hand—steel that is bright and that will harden good. It must be thin; 1-64 to 1-32 inch, according to requirements of die in size.

Take a piece of this thin material, redden it with copperas, and lay the work out on it; being especially careful to get the guide-pin holes *F* F^1 exactly on the center line *G*. Any variation here will increase or diminish the width of the die, according to its distance either way from the center line, as I will explain further on.

Let *B*, then, be the die blank, and *A* the steel template or profile for working by. Instead of laying out and filing the whole contour of the punching, get the one center *H*, as shown. Then lay out and drill or counterbore out the two circles *i k*. Then the balance of the form is filed out to the center line, and a little beyond, as shown by the undotted line. This unbroken line shows the form of the opening in the template, and the dotted line the opening in the die. For a common piece of work like the one shown, the portion of dotted line with *H* for the center might be cut out to complete the form. But supposing the work to be of a kind requiring nicety, then file or work out in any way the half form described. Then place this plate on the die blank; or, rather, drill holes for screws *D D D* (quite small ones), and guide-pin holes *F* F^1, and then harden the plate *A*.

The best way to harden this, or any very thin flat piece, is to lay it on a flat shovel or piece of sheet metal, with a sheet of asbestos on top of the work, while heating. Have ready two bench blocks smeared with oil, and, if convenient, some one to handle them quickly. Then, when the metal plate is hot, drop it onto the lower block, and bring the other block onto it. It will be more apt to come out flat in the process if one of the blocks has pieces on the corners of the same thickness as piece hardened, making the blocks come together evenly on the work. But if the piece is warped, in hardening, it being so thin, the screws *D D D* will bring it down flat on the die blank. The screw holes *D D D* can now be drilled and tapped in the die blank; *A* screwed onto *B*, and steady or guide-pin holes *F* F^1 put carefully into the latter.

Now, if the blank *B* is fitted to a holder, as is usually the case, and screwed into place at *E E E*, having, too, the guide-pin at *C*; then the work can be tested up on the face plate with center *H*, *A* unscrewed and removed, and hole shown with *H* for center bored out to dotted line. Then *A* can be reversed on *B*, by putting it upside down on *F* F^1, screws *D D D* being right, with center line either way. This brings *H* at H^1, and the other side is bored the same way.

I wish to impress, if possible, upon the reader the value of the little rotary files illustrated in Fig. 3. They are home-made and cheap; and, to use an expression more forcible than elegant, they "get there."

For general effective use, I would not recommend making them over ¼ or ⅜ inch in diameter, and from that down to 1-16 inch, as required. They are hardened in oil or water, without drawing the temper. They can be made straight, front or back taper, with round or square ends shouldered for depthing with butt-mill end, as at *F*, or most any form.

B represents a brass rest held in tool post of any lathe to be used in cutting teeth in the files. It has a V-notch in the top, and does not injure the soft teeth on the file. It is more convenient than a lead support. The teeth are cut with any cold chisel, bringing the edge up against the last tooth cut for a guide. Cut the teeth on an angle, all one way or two ways, as shown. But do not cut them backwards and wonder why they do not work well. They act just like any milling cutter, and the edges must point the way they are running.

In Fig. 3 the files, or routers, are cut on

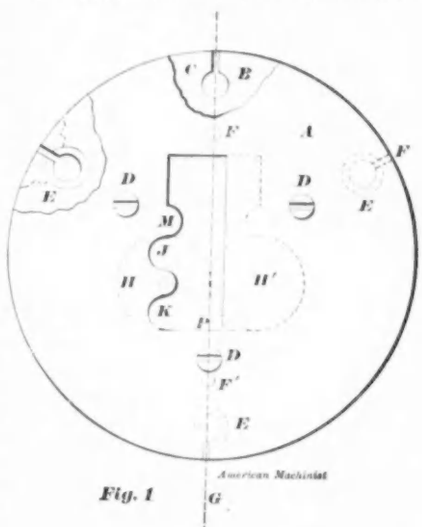


Fig. 1

TEMPLATE FOR DIE.

a back taper, so they can be used with the profile form *A* to finish out *B*, Fig. 1.

Now about their accuracy. The thin edge or profiling contour on *A* is invincible. No file will make any impression on it.

Being thin, it as hard as diamond, and

will take the tops of file-teeth off a very little, so that they will undercut some on the die. If the size is unimportant, it is not worth noticing; but if a positive dimension is wanted, then a file can be cut as shown at *H*, Fig. 3, where a file is cut and a shank turned on the end afterwards. This leaves a good tooth at *k*, where *H* is soldered into *I*. The holder *I* is hard-

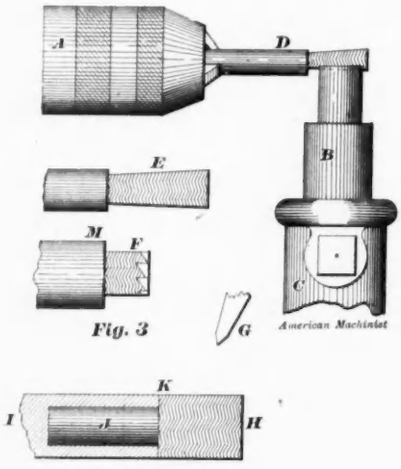


Fig. 3

ROTARY FILES.

ened and turned, or ground down to size of *H* at *k*. This admits of using *I* on a very thin profile edge, while *H* cuts close to it at *k*.

These tools are not intended to take out the bulk of the stock; but when a die or other piece of work is at a place where the workman is beginning to "go careful now," it will rout the residue out while the man is getting ready; and do it on a good sized die, too.

The template is so thin that it can be filed to the outline in less time than it takes to lay it out, and its thinness makes it invertible without changing the form, or necessitating careful filing, except in watching the lines. It can be held conveniently in clamp or hand vise secured in bench vise, and filed in a strong light looked at from above.

So if any mistake is made, it is made in the template; and this is hardly possible if the lines are correct. Once fastened to the die blank, a wayfaring man, though a fool, cannot go wrong. The die blank is held in the hand against the tail-stock drill plate of a lathe, or the bed of a sensitive upright drill, and pushed against the rotary files in motion, the latter cutting until stopped by the profile *A*. The files may be ½ degree taper or more if desired.

With files cut on the end like a butt mill, as shown at *F*, very accurate depthing can be done quickly, after taking out the stock with a drill. A tool like this will sink down, say, 1-16-inch at a cut, and connect drill-hole spaces in a deep track very fast. The straight part *M* can run along a soft profile, as brass or Bessemer steel, for a guide, and cut a track in tool steel rapidly. It is a much quicker way of doing one accurate job, such as model work requires, than trying to work to a line in a milling machine or profile, especially on small-sized work.

In Fig. 1, the curves *i* and *k* allow a rotary file to connect the curve *m* with circle *H*, and line *o* with the same circle. And it will be seen at once that by using but one side on the template for getting both sides on the die, work is not only saved on the former, but the two sides of the die, being made from one outline, are exactly alike. If the holes *F F*¹ are nearer *H* than the center line *G*, they will make the die too narrow; and if on the other side, too wide.

The little slits cut into the steady or guide pin and screw holes, as shown at *F*, prevent the die from cracking when hardened, as shown at *E*, which it will almost always do, unless the holes are filled with pipe-clay or plugged with iron. In Fig. 3, *A* shows how any chuck may be used to hold the files while they are being revolved and cut.

Do not cut the teeth deep, for they will not do as much or as good work as when cut shallower and uniformly. A little trial will soon determine what is right; and after using them for years myself, I find them adopted after once using by others.

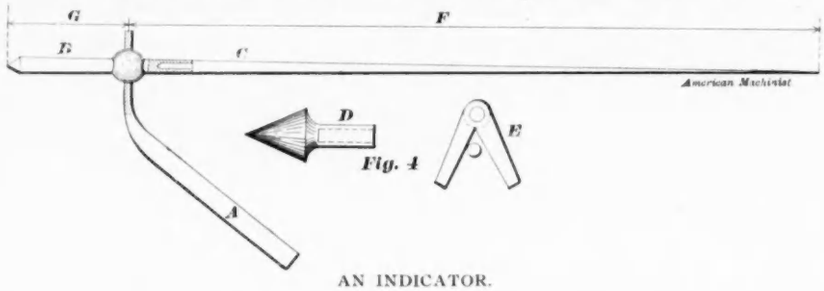


Fig. 4

AN INDICATOR.

In Fig. 1, the straight side of profile is filed beyond the center line of the die, in order to allow the file to work to center; so that when the template is used on the opposite side of die, the top and bottom line of the die will unite.

The two corners not open to the round file can be filed up to the template or guide by hand, without chance of error. Or an upright filing machine of simple construction can be used for such work. A description of such a tool may follow in another article.

Speaking of truing up work for boring, it may be in place to explain the same just now. A tool, not by any means new, is used for this purpose, and can be made in several ways. Some are gotten up elaborately, with universal joint, etc.; but the style shown in Fig. 4 will answer all purposes. *A* is lathe tool stock, flattened on the end quite thin, hole drilled in it, and spring tempered. *B* is steel piece with hardened and ground center, and ball soldered or driven on as shown. This ball rests in the hole in *A*, and the center of *B* is held against the center punch mark or hole in work on lathe face plate, which it is intended to have run true with lathe center. The spring in *A* keeps it in place. *C* is a hickory pointer fitted into *B*. *D* is a large center for holes to put over the end of *B*, and *E* a fork, shown in end view, to be used in the same way for straddling pins to be trued. If *G* is 1 inch, and the point of *B* moves 1-32 inch; then, if the distance *F* is 8 inches, the point of stick *C* will move 8-32 or ¼ inch. When the work on the face plate is knocked around until the point of *C* stands still when the work is revolved, the assumption is that the point where the center of *B* touches must be as "dead as the toe-nails of Julius Cæsar."

Chicago, Ill.

Bicycle Tools—XV.

SPOKE THREADING.

The cycle-wheel spoke has been the subject of great attention, and has varied, in the course of its transformations, from a light piece of hickory in the ordinary vehicle-wheel spoke form, to a piece of slender steel wire; and that wire, slender and light as it is in its original straight form, is commonly made still lighter by reducing the diameter of the principal part of its length. One end of the spoke is provided with an oval head, and often formed with a right-angle bend very near this head, while the other end is threaded to screw into the tapped nipple. The cycle-wheel spokes now used will sustain tensile strains only; they are altogether too slender to support any compression load of consequence; they are not placed in radial lines between the wheel hub and rim, but are spread a considerable distance on either side of the plane of the wheel, to meet the spread of the hub flanges, and are also "laced" or crossed in various ways at some point near the axle. The spokes are tied together where they cross each other; sometimes this tie is a turn or two of wire taken about the spokes at their intersection, and sometimes it is in the form of a metal clip, cut and formed in the press to fit the spoke intersection for, say, a distance of 3-16 inch. This formed clip is slipped in place at the spoke juncture, and then closed with a blow of suitably-formed dies in the foot, hand or power press. The spoke-junction binding, of whatever form, is also often strengthened and secured by soft

soldering, either by use of a flame jet or the soldering iron. The operations on the spoke and hub to make the parts, and the assembling of the spokes, hub and rim, and the truing-up of the wheel after it is assembled, are all difficult, and require either very superior tools or great skill on the part of the workman—one or both. It is a nice operation to reduce the diameter of the spoke wire in the proper place, with perfect uniformity and with such rapidity as is commercially demanded. There may be sixty-four spokes in a pair of cycle wheels; to be good, these spokes should be as near as possible to absolute uniformity in head and body and thread diameters, and in thread pitch. To secure lightness, the spoke diameter is made as small as safety will permit, and the thread diameter should be a very little greater at the root than the body diameter; if the thread diameter at the root is smaller than the body diameter, then the spoke elasticity, under tensile strain, drops to nearly nothing. If the thread diameter and pitch vary, it is impossible to make a good fit between the nipple and the spoke; if the spoke heads are not at right angles to the spoke body, then they do not lie flat against the wheel flanges, and a really good job cannot be made, because, under load, one spoke has less elasticity than another. And so it goes, all the way through the wheel job.

Fortunately, the pneumatic tire puts the whole cycle on a cushion of air, thus giving the cycle wheel the nearest approach to an ideal support possible; hence, a great deal of not absolutely perfect work, in the cycle wheel way, can be used without immediate mishaps, and a very great deal of imperfect wheel work is used in cycles of high grade. I am not sure that such is the case, but I do not believe any perfect cycle wheel was ever put out by any maker—that is to say, I do not believe any cycle maker ever makes a wheel which his own inspector would say was not faulty in minor particulars; and I know, from observations, that a mere novice, like myself, can see abundant defects in the workmanship of cycle wheels in general, if even a very moderate approach to uniformity be taken as a test. I have never seen any lot of cycle wheels of the same kind which were one very nearly like another, throughout. They are perhaps near enough to being alike; yet it would seem, since the wheel is so important a member of the cycle, that there must really be some best form for any certain style of wheel. The wood rim very greatly decreases the chances of wheel uniformity, because the wood rims themselves vary so greatly. If a wood rim cycle wheel be carefully assembled with perfect or tolerably perfect parts, and trued-up so the inside and edges run very close to perfection, that wheel is almost sure to run considerably "out" if it is put into the trial fork and tested half-an-hour later. This shows, of course, an unequal spoke tension. The tendency of the new wheel at rest is to equalize all its own strains; the wood rim stress resistance is less determined and enduring than the steel-wire spoke tension; hence, the rim changes in form under rest duration, and the wheel runs untruly upon renewed trial.

Spoke threads and nipple threads are seldom extremely close to uniformity of diameter.

The Excelsior Needle Co., of Torrington, Conn., supply a great many makers with spokes and nipples. Knowing well the high character of the work commonly turned out by the Excelsior Company, I was much surprised to very recently see the entire floor of the wheel-assembling space of a large cycle factory littered with many hundreds of nipples. Upon asking the cause, I was informed that most of those on the floor had no threads at all in them, and in the others the threads were too large. This shop threads its own spokes; and in another place I saw one wheel, in process of assembling, in which the spoke threads were of different diameters, and the nipple threads were also different, so that in some cases the spokes would not enter some nipples and would enter others. I stopped asking questions right there, from a feeling of delicacy which old shopmen will readily understand; but I could not avoid thinking about what I saw, and I am quite sure that cycle wheels might be better made than they are. Whether such better made wheels—that is to say, wheels with greater uniformity—would be really better and more durable in use, I cannot say. They may be really good enough as they are; and if so, it would be folly to put more money on them to make them better. But as the nipples and spokes came to the assemblers in the instance just mentioned, it would have been money in the pockets of the piece workmen who were putting up that lot of work, if the work had been better, and it could have been made much nearer to a small variation limit than it was made, without appreciable added cost.

The shops here in Chicago do not reduce their own wheel spokes, and I shall be obliged to defer a description of spoke-reducing machines. The first operation on the spoke after reducing is threading, and this is done in two different ways, by rolling and by cutting with dies.

In threading spokes with dies, as practiced by many prominent makers—the Monarch, Gormully & Jeffery and the Columbia among them—the threading dies are carried on a spindle driven both ways; in some cases with one belt and a 3-miter gear reverse, and in others by an open and crossed belt from the countershaft to the spindle pulleys, tapping-machine style. These machines are extremely simple and cheap. The wire is clamped to a slide with a little lever and eccentric clamp — old armory style —

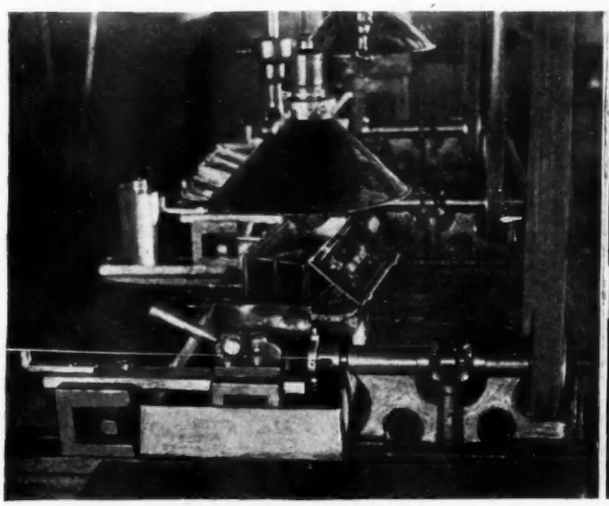


Fig. 97.
SPOKE THREADING AT THE "MONARCH" SHOPS.

Fig. 98.
SPOKE THREADING AT GORMULLY & JEFFERY'S.

handled by a boy, and the clutch driving pulleys run loose on the threading spindle; the rear pulley running the threading way and the front pulley the backing-off way. The threading spindle has a double-end clutch fast on it, fitted to engage either driver, according as the spindle is pushed backward or pulled forward over a small lengthwise sliding distance, enough to clear both driving clutches when the spindle stands in the middle of its travel. Having clamped a spoke to end gage on the little hand-moved carriage, the operator pushes the end of the spoke to be threaded against the die, and thus forces the spindle clutch into the rear driving clutch, and revolves the die the threading way. As soon as the spoke carriage reaches its forward stop, the spindle clutch pulls out of the back driver as the die runs on to the now stationary wire, and the die stops; then the operator gives the carriage a pull, drawing the spindle clutch into the front backing-off driver, and the die revolves in the contrary direction, and runs off the now threaded spoke end. Fig. 97 shows the "Monarch" 3-miter, gear-reverse spoke threader; and Fig. 98 shows the G. & J. open-and-cross-belt-reverse threader. The production is about the same—say 4,000 to 4,500 spokes per day per machine.

In some shops the boys gage their own work and adjust their own dies. The diameter of the thread cut on the spoke by this method depends entirely on the care and skill of the boy who operates it. This boy is working by the piece. It would seem that a much better arrangement would be had if the spoke ends to be threaded were put through successive dies, as might be easily done without taking more time. In this case the spoke carrier must have motion in two directions and there must be a spindle for each die—say three spindles. These three spindles are set up with three dies of two sizes, one on each of the spindles—the two small dies being on the first two spindles, and the large die on the third spindle; the first die and the third die being the gage limit apart in diameter when new. The third die would never do any work until after both of the others were worn out, and the two other dies would not need to be touched until the third die began to work; the third die would not need replacing once a year, and the work could not possibly vary from the limit. The Pope Co. use a 3-spindle spoke-threading machine. They would not let me photograph it, and I therefore did not look at it. It may involve the use of dies, as I have specified; but I think not. The rig I propose would infallibly make uniform diameter spoke threads permanently in any shop which used it.

Rolled threads are made on the well-known Blake & Johnson thread-rolling machine, Blake & Johnson, Waterbury, Conn., and on the Rudolphe & Krummel spoke thread roller. These are essentially the same machine which Blake & Johnson have made for a great many years. They designed this machine for threading short work, and, hence, stood the dies up edgewise, leaving the opening vertical, which is the most suitable form for threading short pieces. To adapt this machine more particularly for threading long pieces like cycle spokes, Rudolphe & Krummel make the working plane of the dies horizontal, as shown in Figs. 99 and 100, the wire lying horizontal, and traveling along the horizontal wire guides as it is threaded, and falling into the hook ends of the wire guides when the threading is completed. The R. & K. dies are cut with a gang of mills made by Brown & Sharpe; and extremely difficult as it is to put up a gang of V-dies of uniform diameter and thickness, as is needed to cut thread-rolling dies, these mills make a good job, and the R. & K. spoke-rolling dies are very nearly accurate in pitch.

In case of a rolled thread made with a square-ended die, it is obvious that all of the turns of the thread must be started at the same time; and it is also evident, upon a moment's thought, that this simultaneous thread inception must cause violent strains, not only upon the work, but upon the die. The stock is moved, and must go somewhere. There is a natural movement of the stock to elongate the part in process of threading; but no elongation can take place, because movement in the axial line is restrained by the V-grooves of the dies which form the threads. The remedy for this is found in removing the die threads so as to form an acute angle in the field of threads on the die face, the point of this angle being the outermost V of the die, which forms the innermost groove of the thread on the spoke end, or piece to be threaded; so that the first swedging of the stock takes place at the inside end of the thread, and the other threads are begun, in regular succession, later in the stroke of the threading die. By this expedient the stock is allowed to move endwise, or axially; and this movement greatly lessens the work on the dies, and so prolongs their life, and at the same time a better thread is formed on the spoke end.

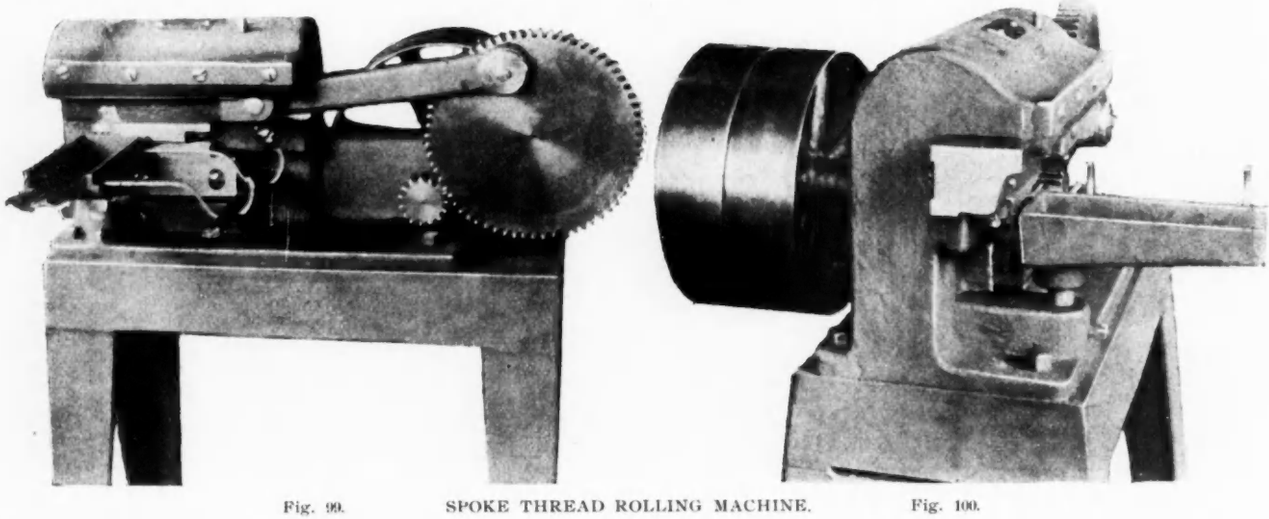


Fig. 99. SPOKE THREAD ROLLING MACHINE. Fig. 100.

Forty revolutions per minute, the speed recommended, gives 24,000 double strokes in ten hours; and the capacity of this machine may be rated at 10,000 to 12,000 spokes threaded per day.

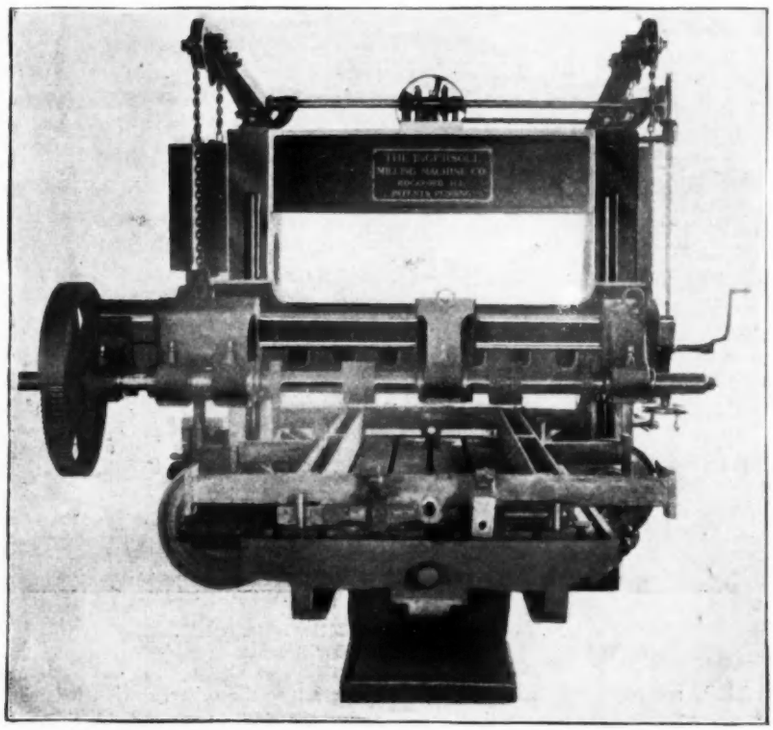
The large crank gear turns top to the right, which makes a small rod angle, long-time working stroke and quick return, where the slide rod-pin is, as is the case in this machine, located half the crank radius above the crank center.

HUGH DOLNAR.

Though we provided for an unusually large demand for copies of the "American Machinist," yet we find ourselves short of the issue of January 9th, and there has been some delay in filling orders for it. We expect soon to receive an additional supply, and will then fill accumulated orders.

A Job of Milling.

We give herewith engravings showing the method adopted for milling a job, which, owing to the fact that several surfaces are to be tooled in exact relation to each other, and for other reasons, constitutes an especially favorable example for milling.



A JOB OF MILLING.

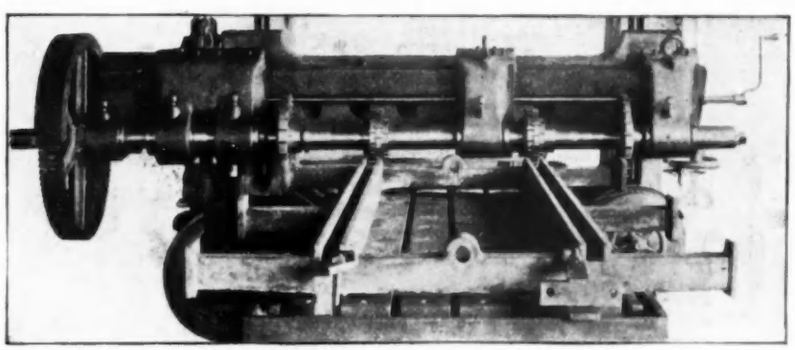
The casting, shown on the platen, is part of a printing press, and the machine takes in 60 inches between housings.

Fig. 1 represents the first operation of milling on these trough castings—surfacing spots on the bottom for clamping the work flat on the table. The mill arbor carries four "Ingersoll" surfacing cutters, making 25 revolutions per minute; feed, 5 inches per minute. The middle arbor support is supplied as shown in photograph, on account of the great width of machine. This gives about 30 inches between arbor supports.

Fig. 2 shows part of the same machine milling the trough side of the casting. The two troughs to be channeled out are 2¼ inches wide, 1⅞ inches deep; milled also on top of trough flange. The arms are also finished at the same pass through the machine. This casting was finished complete in less than one hour and fifteen minutes—that is, the bottom was first milled, as in Fig. 1, and then the troughs were channeled and the arms milled, as in Fig. 2. This same machine is also used for type-setting and ink-distributing tables, up to 36 inches wide. The spindle is powerfully geared; arbor, 3 inches in diameter and well supported. The table is 42 inches wide; 8 feet between pockets, with automatic variable feed from 3-16 inch to 10 inches per minute; quick return by power.

In taking the photograph, the camera was placed directly in front of the machine and at an elevation, so as to show more plainly the shape of casting. This gives the entire machine a somewhat squatty appearance. It is built by the Ingersoll Milling Machine Co., Rockford, Ill.

Mr. John Wallace, C. E., of Bombay, India, editor of the "Indian Textile Journal," has devised a system of ventilating and at the same time moistening the air of a cotton mill, which is said to entirely overcome most if not all the difficulty that has been heretofore experienced in doing this, and to make India cotton mills much better able to produce fine grades of goods.



SECOND OPERATION.

Care of the Modern Marine Boiler.

BY T. W. KINCAIDY,
Passed Assistant Engineer, U. S. N.

The advent of high steam pressures in marine practice brought with it two features of note, namely, the use of fresh water in the boilers, with means for replenishing the waste, and feed-water heaters. It is true that fresh water was often used in the old practice, and feed-water heaters were not wholly unknown; but, as pressures rose and finally got well past the 100 mark, it began to be given out on authority that fresh water must be used in order to avoid the formation of scale on the heating surfaces, and the consequent overheating and rupture of the parts under the high pressures used. And, further, the increase of pressure called for thicker plates and larger rivets in boiler construction, giving the boiler less flexibility and greater liability to rupture under unequal expansion.

Many vessels, particularly those of the merchant service, can and do carry a sufficient supply of fresh water in double bottoms or in special tanks, to make good the unavoidable waste. Others make use of evaporators, the scale deposited from the sea water being more conveniently removed from evaporator tubes than from the crown sheets, tube sheets, and tubes of the boilers. The attendance on the evaporators usually calls for the services of an extra man on each watch; and, besides, there is usually a bill for packing, gage glasses and general repairs, not to mention interest on investment; so that the ship-owner is not long deluded with the idea that an evaporating plant furnishes make-up feed free of cost.

The virtues of feed heaters are very generally conceded. Feeding a boiler with well-heated water not only diminishes the risk of leakage and fracture, but is believed to conduce to economy of fuel, even when steam from the boiler is used as the heating agent. Heating the feed with the uptake gases is not so generally practiced at sea as it probably will be in the future, when the perfect heater shall be discovered.

Now, as a matter of fact, even when evaporators are fitted to ships, their existence is often ignored by the chief engineer, who is apt to look upon the things as unmitigated nuisances. If he wants to make up feed, he uses salt feed; and, it must be confessed, if his internal feed pipes are properly arranged, there is no harmful result. If the feed water, after passing the check valve, is led through, say, twenty feet of internal piping, and then allowed to mingle with the surface water of the boiler, we have then an arrangement which constitutes the boiler its own feed heater. The sulphate of lime is precipitated in the body of the water (whose temperature, with steam of 160 pounds' pressure, is about 371 degrees Fahr.) before it has time to reach any of the heating surfaces, and the result is a boiler free from leaks and scale, and absolutely clean, with the exception of a little mud in the bottom, which can be blown out.

Live steam heaters, with removable pans for catching the scale, are sometimes fitted over marine boilers, the heated and purified feed entering the boiler by gravity. Such an arrangement is to be recommended in the case of water-tube boilers where it is inconvenient or impossible to fit internal feed pipes.

The Original "Machinery Doctor."

It must have been Lord Rosse. A friend of the technical press tells how the Earl of Rosse once strayed into an engine room, and, after looking around in a desultory way for a minute or two, suddenly pulled out his watch and stood there apparently intently timing something, when the engineer's attention was attracted and he exclaimed,

"Well, what's up now? What have you got to find fault with?"

"Oh, it's all the same to me. I've no fault to find. I'm only waiting till the boiler explodes."

"The boiler explodes! Why, man, you are crazy."

"Well," retorted the earl, "if you work ten minutes longer with that screw loose, the boiler will certainly explode."

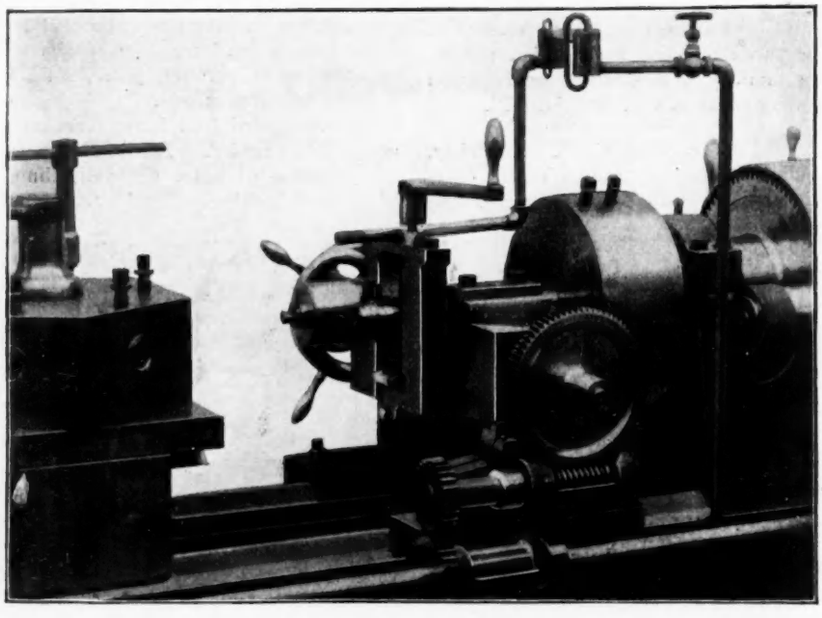


Fig. 2. BICYCLE HUB-TURNING MACHINE.

And then the engineer turned pale and jumped up to stop the engine, and blurted out:

"Why didn't you say so sooner?"

"Why should I when I've never before had a chance to see a boiler explode?"

A New Bicycle Hub and Screw Machine.

We present herewith front and rear views of the essential parts of a new bicycle hub and screw machine, which is readily and quickly convertible from the one function to the other, so that it is capable of turning hubs, cups, cones, axles, screws, studs, etc., with nearly equal facility. The machine has the Parkhurst wire feed complete, and friction clutch back gears. The hub-turning rest and the steady rest for the bar and cutting-off rest form a single attachment, with a large bearing on the bed and gibbed directly to it. The machine is shown with a wheel hub in the steady rest, and another in process of turning. The roughing tool, which is at the back, while the finishing tool is in front, is serrated to break the cut, and both tools are sharpened by grinding on the end. The roughing tool cuts in advance of the finishing tool until nearing the size, when, by an increased feed, the front tool is advanced to do the finishing, an automatic stop permitting an adjustment to .001 inch. The turret is made either hexagonal or round, as may be desired. The index plate is tool steel, hardened, and also the locking key, with a taper gib wedge to take up the wear. The feed will carry a 3-inch drill into solid, hammered, crucible spindle steel. A double cut-off screw machine rest is furnished with the machine. The principal dimensions are as follows:

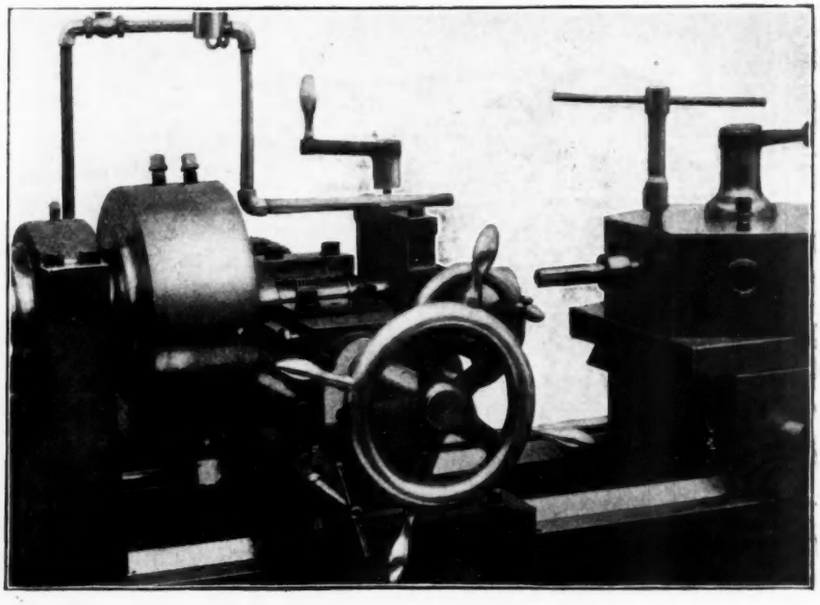


Fig. 1. BICYCLE HUB-TURNING MACHINE.

Swing over bed, 22 in.
Length of bed, 7 ft.
Weight, 4,500 lbs.
Hole in spindle, 3¼ in.
Takes through wire feed, $2\frac{7}{8}$ in.
Diameters of spindle cone, $7\frac{3}{16}$ to 13¾ in.
Width of cone, 4½ in.

Center of holes in turret above turret slide, 3 in.

Length of turret slide, 2 ft. 8 in.

Turret measures across flats, or same diameter if round, 13½ in.

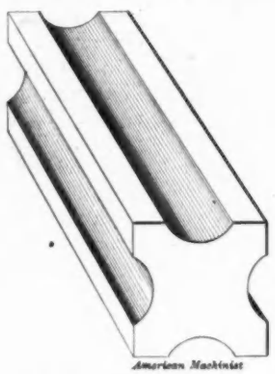
Length can mill when turret revolves automatically, 24 in.

Length can mill when turret revolves by hand, 30 in.

The machine is built by the Lodge & Shipley Machine Tool Co., Cincinnati, O.

Turning Chilled Rolls.

Those who have essayed turning chilled rolls for the first time have not been pleased with the experiment, nor usually satisfied with their success. It is an art in itself; an art which perhaps the late Morton Poole, of Wilmington, Del., did more than any other one man to bring to perfection—and to perfection he certainly brought the grinding of chilled calendar rolls for paper-making. Before, however, the grinding operation is commenced, there must be as nearly perfect work done by the lathe as it is possible for such an imperfect machine tool as a lathe to perform; but most tools for this work have the double disadvantage that they do not do good work and do not work fast enough. The work reminds one of the Scotchman's porridge, "cold, burned, sour and gritty; and, damn it, there was not enough of it!" But by the use of a simple tool such as is shown in the sketch, the work is rendered very easy, and its quality—for lathe work—leaves nothing to complain of.



ROLL-TURNING TOOL.

A plain bar of tool steel is taken, about 1¼ inches square; about 4 inches of it cut off, and then fluted on each side with a semi-circular channel of about ⅜-inch radius. All four sides of the bar being then ground so that the four angles are exactly 90 degrees each, the tool is ready to be clamped in the tool-holder and set to work. It does not remove curls of material, but takes off a series of brittle, thread-like turnings, about the size and general shape of pine needles. When one band 4 inches wide is turned, the tool is moved along. G.

Radial Drill Press.

We give on this page an illustration of a radial drill, the principle of which will be so readily understood from an inspection of the engraving as to make detailed description unnecessary.

It will be seen that the tool is of the class in which the arm is attached to a saddle, which saddle is gibbed to sliding surfaces forward on the face of column.

Things are so arranged that long belts are used, and the back gears are placed at the spindle; thus making use of the gearing only when needed, and then closest to the work.

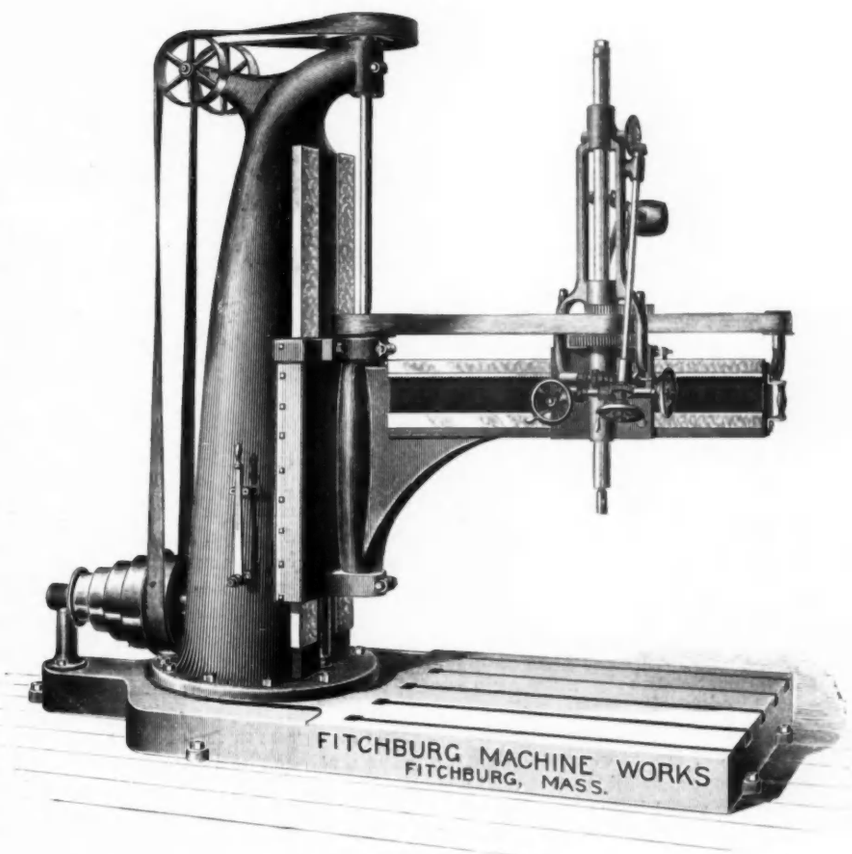
There are eight changes of speed and six of feeds, the latter by means of cone gears with a pull key.

The drilling head is moved along the arm by means of a rack and pinion, and can be clamped to the arm when desired. The arm is raised and lowered by power, and swings on ball bearings, but can be clamped in position.

The countershaft has a reverse motion for tapping.

Spindle is 2⅜ inches diameter, and has a traverse of 16 inches; traverse of head on arm is 41 inches; greatest height from bed-plate to spindle, 76 inches; greatest distance from face of upright to center of drill, 72 inches.

The machine is made by the Fitchburg Machine Works, Fitchburg, Mass.



RADIAL DRILL PRESS.

The Measure of the Instantaneous—The Time Occupied in Oil-Engine Explosions.

BY TECUMSEH SWIFT.

I am inclined to think that mechanics seldom use the word "instantaneous" correctly, and I even doubt if the mechanic has much right or occasion to use it at all. An instant is a point of time without duration, and anything to be done instantaneously must be done without occupying any time in the doing. Nothing can can be done in no time. The greatest thing that can be done in no time, and the only thing, is no thing. Some things can be done very quickly, but they still occupy some time. Between the beginning and the ending there must be an intermediate interval. A hammer falls quite quickly, but the world is older when it gets to the anvil. The hammer may be stopped still more quickly, but not instantaneously. A hardened hammer face may strike a hardened die, but the elasticity of the material, or its fracture, must provide a certain interval of time for the stoppage. Explosives act very quickly, but that they are not instantaneous is evidenced in the fact that some do their work much quicker than others, and the time of their operation may be graded to the work to be done. A heavy gun must not be charged with quick-burning powder. The shot

cannot move quick enough, and the gun must burst. For rending rock, the quicker the explosive can be made to act the better, and improvements in explosives for such service consist in getting those which will act still more quickly.

The thing which is most desirable in one place may be most objectionable in another. Explosives for blasting in quarries are the right thing in the right place, but there is a prejudice among mechanics against the use of explosives for driving machinery. The gas engine and the oil engine have had more or less to struggle against this prejudice.

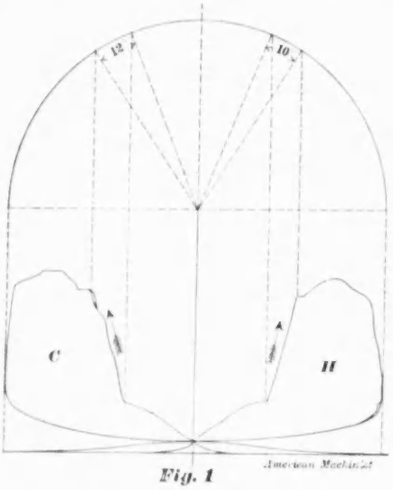


Fig. 1

Mr. John Randol, in his second article on the Kane-Pennington motor, has done a double service to the mechanical world. He has shown, so that it is now generally understood, that an igniting spark in an oil engine, or a gas engine, is more effective and serviceable if applied at the right time than if applied at the wrong time; and he has also shown that a second igniting spark, at the wrong time, and after a first spark at the right time has done its effective work, is not of much account. These are important things to know, and no doubt the world is duly grateful.

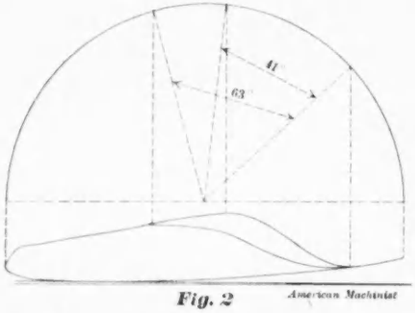


Fig. 2

But Mr. Randol, in the article referred to, has done us another service of great value, but which may not receive due attention and appreciation unless I point it out. He provides the means of showing very clearly the time occupied by the so-called "explosion" in the oil engine, and the result of the showing makes it appear that the time occupied by the explosion, and consequent increase of pressure, in the oil or gas engine is decidedly greater than the time occupied for steam admission in the average steam engine. In the steam engine, and also in the oil or gas engine, the most critical of the whole cycle of operations involved unfortunately occur when the piston is at or near the end of its stroke, and when, consequently, the indicator has little or no movement; so that it is impossible for the indicator diagram to tell us precisely what is going on at this time, or to tell us the time occupied for any detail of operation. The admission of steam to the cylinder in the one type of engine, and the ignition and deflagration which produce the initial pressure in the other, are certainly operations concerning which we should know all that we can. In the same issue of the "American Machinist" which contained Mr. Randol's first article upon the Kane-Pennington motor (November 7th), there were reproduced a pair of indicator diagrams from a Corliss steam engine, having the peculiarity that they were taken while the indicator drum had a movement coincident with that of the valve-operating eccentric, instead of, as usual, representing the piston movement. In the issue of November 28th I struggled with those diagrams a little, finding out, in a backwoods sort of a way, where the different operations of the revolution occurred. It providentially appeared that the steam admission occurred while the drum was moving; so that from those diagrams it is quite possible to get an idea how long it takes after the opening of the valve for the steam to get up to its full pressure in the cylinder. From the diagrams as here reproduced, Fig. 1, it appears that steam admission occupies from 10 degrees to 12 degrees of the complete revolution of the engine shaft.

Now, taking the last of Mr. Randol's oil-engine diagrams (Fig. 2), in which the "explosion" is purposely made to occur too late, and where the actual ignition occurs after one-seventh of the stroke is made, it appears that the actual time occupied for the completion of the combustion is in one case 41 degrees and in the other case 63 degrees of the revolution, the slower combustion being when there was less to burn, instead of, as might perhaps have been anticipated, when the amount of combustible was greater. These diagrams speak for themselves, and it is not necessary just here to add a word. They seem to completely explode the explosion idea.

Spray Nozzles for Cooling Water of Condensation.

From numerous inquiries received on the general subject of cooling water, so that it may be used over and over in places where the supply is limited, we judge that the following, which we translate and condense from "L'Industrie," Brussels, will be of interest to many of our readers.

Fig. 1.

SPRAY NOZZLE.

In the system here illustrated, a spray nozzle, Fig. 1, is employed. The nozzle is provided with a helical passage, which gives the water a gyratory movement and produces a continuous spraying, even with a low pressure and with orifices of considerable size. Nozzles may be used as large as ¾-inch diameter; so that if the water is impure, there is no danger of obstruction, and a great volume of water may be sprayed with a few nozzles, and at small cost for installation.

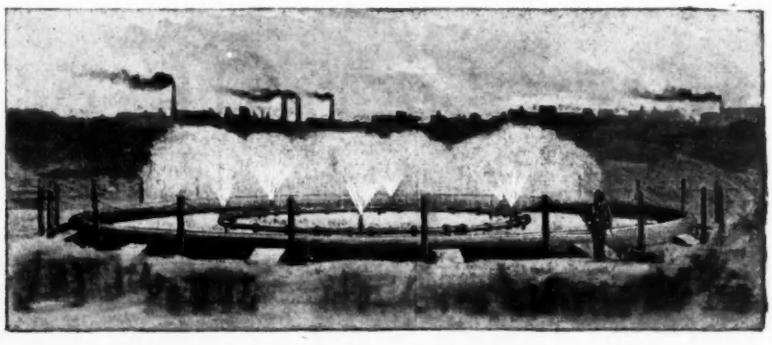


Fig. 2. A LARGE COOLING BASIN.

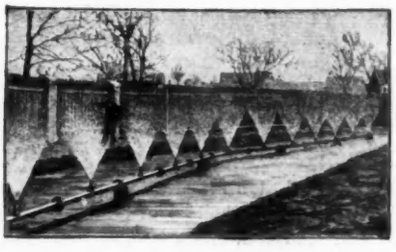


Fig. 3. A COOLING CANAL.

The power required is no greater than for other systems of cooling; and the division of the water into fine spray causes an

energetic evaporation, and a rapid reduction of the temperature to that of the surrounding air.

The nozzles are generally used in connection with a basin or reservoir of water below them, Figs. 2 and 3; they can as well be located on the roof of the engine room, in which case the water is collected

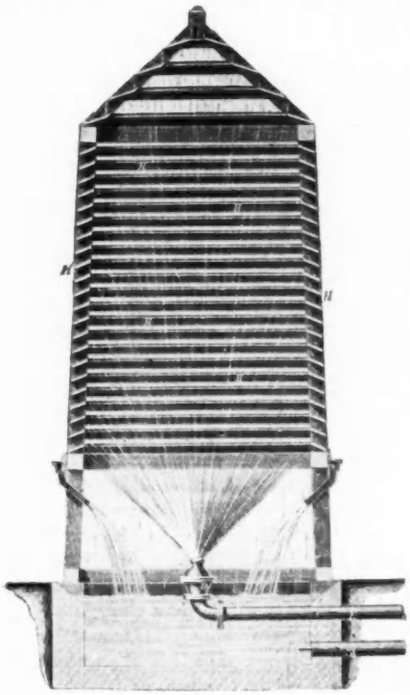


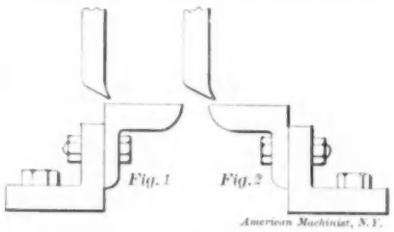
Fig. 4. PERSIAN KILN.

in a gutter of sufficient width, from which it flows to the tank of cold water below. The installation shown in Fig. 2 is employed in the Skally mine in Upper Silesia. It comprises 12 nozzles and cools 450,000 gallons per hour.

If the space occupied is objectionable, the nozzles may be inclosed in a "Persian kiln," Fig. 4. The loss of water with this arrangement is quite small. It is not greater than where artificial ventilation is employed, and the consumption of power is much less. With a ventilation system, the power is generally estimated as 3 per cent. of the power of the engine, but it is really higher in the majority of cases.

The Springing of Planer Work and Planer Tools.

A correspondent sends us a couple of sketches, which we give below, showing an angular piece strapped to an angle plate, and he asks us which is the proper way to place it on the planer, whether as in Fig. 1, or as shown in Fig. 2. We strongly suspect that our friend knows pretty well which is the right way in the case. When a young mechanic gets so that he can ask such a question, he is very near the answer, and the question may be more for corroboration and approval of the answer already reached than for information. The trouble, generally, is that the question is not asked at all, rather than in any difficulty about finding the answer. In the shop, we have seen a great many cases where, evidently, the question had not been asked, or the work would not have been placed so that chattering, catching or breaking of the tool or the piece of work must, of necessity, and did inevitably follow. The sketches answer themselves. Assuming that there is any springing of the work under the thrust of the cut—and this may always be assumed, the work should be so placed that it will spring away from the cut rather than spring toward it. When it springs away from the cut, that is the end of the matter. As soon as it springs away enough to obtain an increased resistance equal to the thrust, then the springing stops and the cutting operation

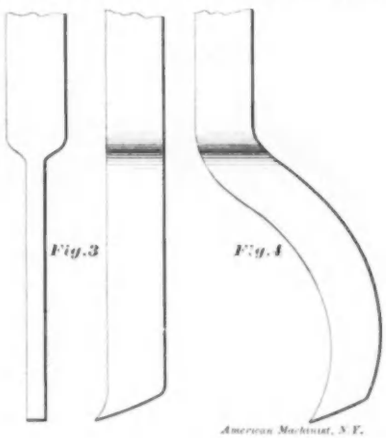


THE RIGHT AND WRONG OF IT.

can go on smoothly. But if the piece is so placed that in springing away from the forward push of the cutting edge it must spring upward instead of downward, then its springing leads to a bad complication. The springing up of the work is equivalent to a springing down of the tool, and means that the tool will dig in. The first springing of the work may be carried beyond what is required to establish an equilibrium, and then it immediately springs back too far, and in this way chattering is caused. If there is no recovering spring of the work, then either the planer must stop, the work must be thrown out of place, or something must break.

One of the most perplexing things that the machinist encounters is the chattering or vibration of either the tool or the work, and it makes little difference which. Chattering is caused by unstable equilibrium, by a springing of either the work or the tool which does not simply and exactly satisfy the resistance to be met, but which overdoes the requirement and then reacts to excess. So far as the chattering is caused by the springing of the work, the workman is chiefly responsible for not placing and securing it properly. Occasionally there is something in the design of a casting that makes it impossible to avoid some chattering under the cut; but instances of this are rare and should be impossible.

Where it is the tool that causes the chattering, instead of the work, there may be two or three causes for the trouble. The design of the tool itself may be bad, it may not be held securely in the tool holder, something may be slack about the machine, or the design of the machine itself may be to blame. It is a rather singular fact—familar, no doubt, to many mechanics—that the planer in use in every machine shop is far from correct in the mode of carrying the cutting tool. The tendency of the tool and its carrier, in springing when cutting, is always downward, or in a direction which must cause the tool to dig into the work. The higher the saddle is used above the work, the greater must be the tendency of the tool to dig in, on account of the increased leverage given to the tool. Many years ago, in a certain shop, at a time when work was slack, an attempt was made to cut up the rim of a heavy fly-wheel into pieces suitable for melting in the cupola. The rim was about 18 inches square, and a section of it was laid upon the planer, with the intention of cutting into it, half way through or more, with a square-nosed tool. The tool chattered badly from the first, and the deeper the cut the worse the chatter; and before the first cut was finished, despair settled down over the whole affair. The winter of our discontent was made glorious summer by the use of Fig. 4, instead of Fig. 3. The tool with the curve backwards had, of course, more spring than the straight tool, because for the same depth of cut there was more length to it; but the direction in which it sprang was such as to compensate or neutralize, the downward spring of the



A SPRING PARTING TOOL.

head, rather than to augment it. If a tool-holder could be devised for the planer so that, with the present overhang of the tool, its cut occur upon the backward stroke of the planer, it is certain that much smoother cutting would result. The idea embodied in the draw-stroke shaper would seem to be a correct one.

Our correspondent, Mr. W. H. Wakeman, of New Haven, Conn., is interested in a new society which is to be organized in New Haven, to be known as "The Amalgamated Engineering Society of New Haven." It is composed of engineers, electricians, firemen and machinists.

Operating a Steam-Heating Plant.

BY W. H. WAKEMAN.

There are so many different kinds of steam-heating plants now in use that it is not expected that one article will cover the whole of them. Let us first take the case of a plant where the exhaust steam goes into pipes under no pressure except that necessary to force it around the rooms, which pressure should not exceed one pound by the gage. As this is not sufficient to warm the buildings, other coils or banks of pipes have been put in to make up the deficiency, and in these live steam at boiler pressure is used, the condensed steam being returned to the boilers by means of a trap.

When the engineer comes in the morning it is assumed that the rooms are cold, with but a low pressure on the boilers. I do not consider it a good plan to immediately turn on the steam, for in that case the pressure will fall still lower, and it will be necessary to force the fires very hard for a time in order to raise the pressure and at the same time supply steam to the factory. It is much better to get into the boiler-room a few minutes earlier in the morning, get up as much pressure as the law allows, and, with fires in first-class condition, turn on the steam and begin to heat the rooms. If the engine is so constructed that steam can be blown through the steam-chest and cylinder, the pipes may be warmed up in this way; but it is better to have pipes connected from the boiler directly into the exhaust heating pipes, so that steam may be blown directly into them before the engine is started up. It is a good plan to have one of these live steam pipes discharge into the exhaust pipe near the engine, and another one at a point about midway of the system, for in this way the heat becomes available at short notice. Where these pipes enter they should not be merely tapped into one side of the large pipe, and allowed to discharge squarely against the opposite side, but should be connected in such a way as to form a siphon, the steam thus drawing the steam already in the pipes after it, instead of proving an obstruction to its passage.

When steam is admitted to the high-pressure part of the system, the first water that comes to the receiver will be cold; and if all of the drip valves are shut, it will cause heavy pounding in the pipes, and may cause an accident.

I have found it to be better to open the drip valves and allow this cold water to go to the sewer; and as soon as the pipes are well warmed up, to shut the drips; and having admitted steam to the trap, let it take care of the water of condensation, which it should do without shock, pound or jar. Mention is made of the necessity of admitting live steam to the trap, for it is better to shut it off at night rather than to leave it turned on at all times.

The adoption of this plan causes a waste of water, it is true; but in places where it is an object to save it, provision may be made for letting it run into a tank, and afterwards pumping it into the boilers. If the trap does not take the water out of the receiver and put it back into the boilers again, it may be due to either of the three following causes: The steam pipe from boilers to coils may not be large enough to maintain boiler pressure in all parts of the system. The check valve between trap and boiler may not be perfectly tight; thus allowing water to be forced back form the boilers, instead of having it come from the receiver. The valve which admits live steam to the trap, commonly called the "equalizing valve," may not be tight; and if it is not, then it will be impossible for the trap to work.

When exhaust steam is used for heating, and there is not enough of it to heat the whole factory, it is a good plan to run the injector to feed the boilers; for in that case less steam is condensed in the heater than if the pump is forcing cold water through it, and unless the heater is well drained the water will be forced into the heating pipes where it is not wanted.

If an engine is overloaded, it is well to have as little back pressure as possible, and also, if all of the exhaust steam cannot be used; but otherwise the added back pressure is no detriment, for the extra steam from the boiler, that is required to overcome this back pressure, goes into the heating pipes and is there utilized.

In other plants, where power and heat are both needed, it is customary to put a reducing valve near the boilers, and thereby reduce the high boiler pressure to a low pressure in the system. The engines and pump also exhaust into the system.

When steam is first admitted to such a system in the morning, the valve should not be opened wide and the full pressure turned on, but the pipes should be gradually warmed up, in order to prevent excessive water hammer. There will be water in the receiver, and this, together with the first water that comes back, will be cold; and this cold water should never be pumped directly into the boilers.

As the speed of the pump is usually regulated by means of a float in the receiver, which is connected to the lever of the throttle valve of pump, it will be run at a rapid rate, which makes it all the worse for the boilers, as they will be partially filled with cold water, and consequently will suffer from unequal contraction. To overcome this difficulty, the water should be pumped through a heater, supplied with live steam, until the receiver is well warmed up, when it may be put directly into the boilers.

Where steam is admitted to a system under from 50 to 80 pounds pressure or more, there is usually little or no trouble caused by air collecting in the pipes; but where the pressure is, say, from 2 to 5 pounds, air will collect in the radiators and pipes, unless some way is provided for it to escape. This is usually done by means of automatic air valves, which are so adjusted as to be open when cold, but when steam strikes them the metal expands and they close tight. Frequently these valves are not properly adjusted, and it takes a long time for the rooms to get warm. They should be set so as to be open but a very little when steam is on and they are well warmed up; then, when cooled off, they will allow the air to escape freely.

If there is no separator between the engine and the heating system, the engineer cannot prevent the cylinder oil from going to the radiators; and in some cases where there is one, it has not been properly used—hence, has been of no value.

Where there is a separator, there must be a drip pipe to carry off the impurities taken out of the main pipe; and if this drip is not left open, the separator will fill with oil and dirt, after which it is of no value—for, as it can hold no more, the rest goes on to the system and thence to the boilers. If the drip valve is left wide open, steam will be wasted; so the engineer sometimes shuts this valve tightly, intending to open it when the glass gage on the separator shows some water; but as other duties take his attention, the glass is filled to the top, and so has the appearance of being empty, unless close observation is made. I have found it much better to leave the drip valve open just enough to keep the separator free from any accumulation of water.

If no separator is in use, and the engineer cannot get one, he may provide a substitute by putting a tee in the return feed-pipe near the boilers, taking care to have the outlet look upward; and into this outlet a piece of pipe may be screwed, and a small valve provided at the top through which to blow it out from time to time. This tee should be in a horizontal pipe, and as far away as possible from any elbow on the inlet side, or the side towards the pump. The philosophy of the arrangement is as follows: The water returning to the boilers through the horizontal pipe, contains oil, which naturally rises to the upper part of the pipe. When it comes to the tee, some of it will rise into the vertical stand-pipe, and may be blown into the sewer. This is not so good as a separator, but is better than nothing.

Usually, the radiators in a building are not intended to stand a heavy pressure, and are protected from it by the reducing valve near the boilers; but as this may fail to operate or become disabled, it is well to see that the back pressure valve is in good order, and that there is not too much weight on its lever, for it may be called upon to prevent an over pressure in the radiators.

If the reducing valve depends on a rubber diaphragm for its operation, it is a good idea to have at least one extra one on hand; so that in case of failure of the one in use, another may be put in without unnecessary delay. When shutting down a plant of this kind, care should be taken to stop the receiver pump before steam is shut off from the system.

With low-pressure systems, where the boiler pressure does not exceed 10 or 15 pounds, and the water returns to the boilers by force of gravity, no reducing valve or boiler-feed apparatus being necessary, there is less to require attention than with any other system; but boilers need almost as much care, even with a low pressure, for they may evaporate much more water than some others that carry a higher pressure, and consequently they wear out fully as fast. Concerning the liability of explosion with such low pressure, I would say that the danger is less, it is true; but still, when I recall an instance where a pipe had been used under 80 pounds pressure for several years, and then, to my certain knowledge, it burst when a correct gage indicated but ten pounds, it shows that care and intelligence are necessary even with low pressures.

Defects in Iron Castings.*

BY D. BROWN.

Failures in castings seem so multifarious and varied, that it is impossible at any time to avoid a certain percentage of bad castings, especially in a foundry doing a variety of work. The first defect we will consider is a very common one—it is the presence of blow-holes in castings.

These are due to a variety of causes—damp sand, defective cores, want of proper venting, and the fact of risers, or "flow gates," as they are sometimes termed, either being too small or not properly situated. It will be readily understood that when the melted iron comes in contact with any damp sand, steam and other gases are formed, which in many cases, not being able to escape from the mold, occupy a certain amount of space to the exclusion of the metal, and, of course, form recesses or holes, which are very detrimental to the strength or appearance of a casting. One very aggravating characteristic of the holes is the fact that they cannot be detected in some cases until the casting has been machined, which, of course, means a loss of time in addition to the loss of the casting. To avoid this, the molder should be very careful about the damping of his sand, which is sometimes rather a difficult problem to solve—as, on the one hand, if the sand is too damp, he has blow-holes; while, on the other, if it is too dry, and there are many sharp edges about the casting, the sand cannot be worked to a clean edge. Excessive dampness, or an accumulation of water, often leads to far more serious consequences than a defective casting. In casting large molds into deep pits, great care has to be taken, as I have on more than one occasion seen explosions occur, although precautions had been taken to build a rough caisson round the pit.

This is a point which seems to be very little known among architects, who, almost without exception, specify all columns to be cast on end, no matter what their length may be. Where this is possible, there is no doubt it is the best way in which to cast a column or cylinder; but in Liverpool, where, in most of our foundries, water is found at no great depth from the surface, it is advisable to cast anything in the nature of a long column or girder on an incline, which is for most purposes as efficient as casting them on end.

The want of proper venting is one of the most common sources of errors in founding. A proper arrangement of vents is of vital importance in any kind of mold, but more particularly in a green sand than in a loam or dry sand mold. The arrangement of vents differs, of course, according to the form of the casting. Venting is performed by means of vent wires, which vary in diameter from ⅛ inch to ½ inch, and from 12 inches to 4 feet long—the smaller ones having an ordinary wooden file handle, and the larger a cast-iron T-handle.

Suppose that we have a pattern in the sand, which is not very large or heavy. When the top part is rammed up and ready to be lifted, then the small vent wire is used all over the top part, passing through the sand till it reaches the pattern. The top part being then lifted off, a small channel is cut with a trowel all round the pattern and 2 or 3 inches from it; then the vent wire, bent so as to pass under the bottom of the pattern, is freely used round this channel, which is intended to connect all the vent holes. Branches are cut from this channel so as to lead all gases away clear of the top part. In larger molds these vents are made before the top part goes on, and the channel cut 3 or 4 inches from the surface. Straw ropes and ashes are then laid in the channels, with branches as before. These are then covered with sand and the joint of the mold made up. The reason this arrangement is made is to avoid the possibility of metal getting into these channels and choking them if the top part should happen to rise. Castings that have a recess or chamber on the under side have to be very carefully vented. We will take an H-girder for example. The usual way of venting such molds is as follows: The pattern being turned bottom up, is filled with sand, rammed up and then vented. It is then turned over and bedded in the usual way, after which a bent vent wire is used, so that we have vent holes connecting with those already there. The top vents, of course, are made straight through the top part.

In the case of a very large or heavy casting, where the side vents as described would not be capable of affording a ready escape for the gases generated in the bottom of the mold, the method of venting is different. A hole being dug out in the sand a little deeper than necessary for bedding the pattern, is covered all over the bottom with a layer of ashes 4 or 5 inches thick. The pattern is then bedded down with a layer of sand, 3 or 4 inches thick, between it and the bed of ashes. Three or four tubes, about 3 inches diameter, are rammed up in the sand round the pattern connecting the ash-bed with the surface, for the purpose of allowing the accumulating gases a free escape to the open atmosphere. Care is taken that the tops of these tubes are all clear of the top part of the mold.

When the pattern is withdrawn from the sand, the bottom part of the mold is freely vented with a vent wire to the bed of ashes. The above examples apply more to green sand than to dry sand or loam. For dry sand the methods adopted are very similar, although not requiring as great attention, owing to the special preparation of the sand and the fact of its being afterwards dried.

In loam molding, again, the loam being made of open, coarse sand, a vent wire is not nearly so often used, but straw ropes and ashes are freely laid in various parts of the mold.

Without going further, I think it will be quite clearly seen how important a thorough knowledge of venting is to a molder.

Another source of blow-holes already mentioned is defective cores, whose defects arise from a variety of causes.

Venting a core is of as much importance as venting the mold itself, and often is a problem of some difficulty.

Take the case of a hollow piston, as they are generally made in cast iron for marine purposes. The core in this case is surrounded on all sides by metal, except at those places where the molder and designer arrange between them to have a small branch through which to vent the core, and also to withdraw it when the casting is made. If left to the molder, he would have a branch top and bottom; but in this case the engineer has to consider the probabilities of the plug, that is afterwards used to fill the branch, coming out when the engine is working, and so causing a serious break-down; and, to avoid this, the branch is generally made in the side. Cores that are not properly dried are a great source of danger to the casting, so that great care is taken with large, heavy cores, to see that they are properly dried. Castings have often been found

*From a paper read before the Liverpool University College Engineering Society, Liverpool, Eng., November 26th, 1895. Condensed by and for the "American Machinist."

useless through an oversight affecting some part of the mold which seemed of minor importance, although great care had been taken with the more important parts. This is often the case where there are many small cores in the casting.

If placed in the bottom of a mold, where there is a good pressure, they cannot do much harm; but if in the top—say, round a flange where they have been arranged to save drilling—then they require as much attention, to see that they are properly dried and vented, as do the large or main cores.

The last cause of blow-holes we will deal with is that due to the improper situation of risers. The riser is an outlet through which escape all the air and gases contained in the mold at the time of casting, and which are, of course, displaced as the melted iron runs in. The proper position of a riser is naturally the highest part of the casting,unless that is where the runner happens to be placed. Should there be several high points, then there should be a riser for each, or there would be certain parts of the mold where air would be imprisoned without any means of escape. A riser is also of use to indicate when the mold is full, as well as for feeding purposes.

Expansion and contraction in their relation to molding are very well understood as a rule by the majority of engineers, especially pattern-makers; but there is one important point very often missed by pattern-makers in making large core-boxes for green sand castings, and that is an allowance for the expansion that takes place in the core while being dried. I have seen a pattern-maker very much perplexed on finding, when the core was put into the mold, only ⅜-inch metal, when he was sure he would have ½-inch metal. He checked over the pattern and core-box (the difference between which represented ½ inch), but could find no solution to the matter, until it was pointed out that probably the core had expanded ⅛ inch, which on trial proved to be the case.

ELECTRICAL MACHINERY.

Electrotechnics—VI.

The Principles of Electricity for Practical Men.

BY FRANK S. MASON.

18. THE LAW OF THE MAGNETIC CIRCUIT. As has been noticed, the fundamental law of the magnetic circuit and the formula expressing it is very simple, viz.:

$$N = \frac{M}{R}$$

in which

N = the magnetic flux,
M = the magneto-motive force,
R = the magnetic reluctance.

When this law is applied to the actual design of an electro-magnet, it becomes necessary to rewrite, in place of this general equation, a formula which accounts for all the particular conditions which exist or may arise.

Thus, R is replaced by an expression which is the sum of all the resistances in the magnetic circuit, as air gaps and joints; and includes the particular conductivity or permeability of the conducting medium, the permeability of air which is practically the same as that of a vacuum being taken as unity. It will be understood that conductivity, or permeability is the inverse of reluctance, the statement that a substance has a high permeability, being the same as saying that it has a low reluctance; precisely as with the electric current, the statement that a substance has a high conductivity is the same, in effect, as saying that its resistance is small.

M is replaced by an expression which involves the exact relation of the current flowing in the exciting helix with the magnetic effect produced, and also includes the volume of current and the turns in the spiral.

N, representing the magnetic flux, must be based upon an intelligible unit, which will give an intelligent expression to the abstract character of a phenomenon which can only be examined by the effects it produces, and is even more obscure than the electric current.

The apparently complex formula resulting is apt to stagger the non-mathematical student, but it must be borne in mind that the formula is actually no more complex than as above. It is multiplicity of parts which is confusing, and one is apt to be too hasty in becoming muddled.

Thus, suppose

$$a = \frac{b}{c}$$

and

$$a = \frac{xy}{z}$$

$$b = ef$$

$$c = lm^2$$

then, if the first expression is rewritten by substituting the equivalents, we have

$$\frac{xy}{z} = \frac{ef}{lm^2}.$$

Each of these latter symbols may in turn have an equivalent which may be substituted, but the whole may be resolved back into the original expression.

A formula may be compared to a machine. As a whole it may be very complicated, yet each piece by itself is very simple; each piece has its place in proper relation with the other parts and the work to do. One not familiar with the machine may take it down and become familiar with each part, and with due care again assemble the parts so that the perfect whole may perform its work. Done once with care, it may be repeated with more ease, and finally with the facility of familiarity. In like manner, a formula may be analyzed and reassembled. But the machine is no less complicated, nor is the formula less formidable, to the uninitiated.

19. MAGNETO-MOTIVE FORCE. We will thus begin with the cause of the magnetic phenomena, viz., the electric current, which is therefore the source of the magneto-motive force. It will easily be evident from what has been written concerning the solenoid, that the volume of the magnetic flux depends upon and varies with the quantity of current flowing through the exciting helix, and the number of turns in the helix.

The conception of lines of force has thus far been used as applying to the direction in which the magnetic force acts. By referring to Figs. 25 and 27 of this series, it will be seen that the iron filings arrange themselves quite densely in the immediate vicinity of the poles—this density diminishing as the distance increases and the force grows weaker. This suggests the idea that the strength of the field at any point may be expressed by conceiving a strong field to have many lines and a weak field few lines, and the strength of different parts of the same field may be expressed in the same way.

To do this intelligibly only requires a unit strength of field to be established. Remembering that the centimeter (about four-tenths of an inch) is always used in this connection, imagine two poles placed a centimeter apart, and suppose that the poles are of such strength that they attract or repel one another by a unit force. Then the poles are unit poles. Now imagine one pole removed. The field of the remaining pole, at a centimeter distance, is of unit strength, and is supposed to have one line of force passing through each square centimeter of cross-section perpendicular to the lines of force.

Next imagine a sphere surrounding the pole with a radius of one centimeter. As is well known, the surface of a sphere is equal to $4\pi \times r^2$; or, since here $r = 1$ centimeter, the surface of this sphere is 4π square centimeters, or about 12½ square centimeters. Each square centimeter has one line of force passing through it; so that for the whole sphere there are 4π, or nearly 12½ lines of force—that is, 4π lines of force radiate from a unit pole. This unit pole is a very weak one; and, in point of fact, large numbers are required to express the strength of the fields actually used.

The lines of force are thus used as a

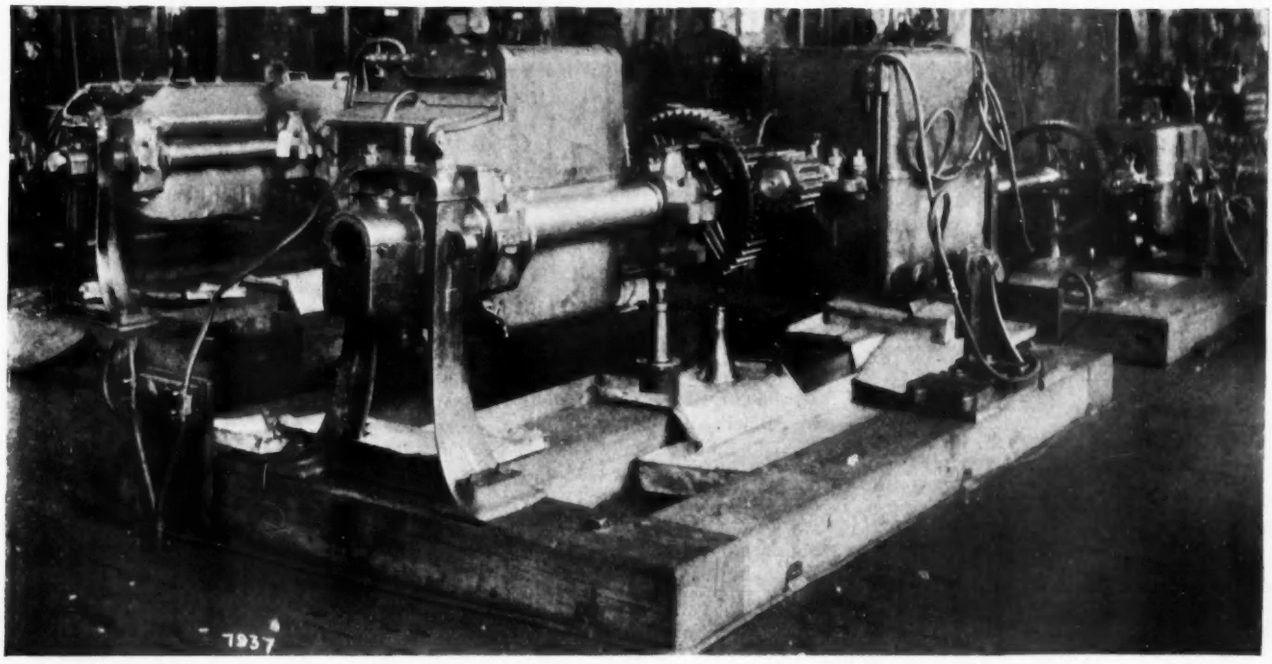
measure of the magnetic flux—the statement that the magnetic flux consists of so many lines of force being comparable to the statement that the electric current consists of so many amperes, and, as stated above, this magnetic flux is equal to the magneto-motive force divided by the reluctance, just as the electric current is equal to the electro-motive force divided by the resistance. Different substances, as air and various grades of iron, have different factors of magnetic reluctance, just as different substances, as copper and iron, have different factors of electric resistance.

Let us now suppose that an electric current is flowing about a single turn of a conductor, and of such strength as to produce a magnetic flux of ten lines. If we add one more turn, the magnetic whirl thereof will, as we have seen, join that of the first turn, and, manifestly, the magnetic flux will be doubled, or consist of twenty lines. Each additional turn in the spiral will add to the total number of lines, until the magnetic conductor is saturated and can carry no more lines within the limit of economical results. It would be incorrect to say that no more lines could be forced through the magnetic field; but it is true that there is a point of saturation where additional magneto-motive force does not produce the same effect as at the first, and in place of the ten lines above assumed, many less could be driven against the reluctance with each additional turn in the spiral.

This point of saturation would be governed, as will be seen, by the specific reluctance of the conducting medium, the length of the path, and the area inclosed by the spiral, precisely as in the case of any fluid motion.

If, instead of adding turns to the spiral, we increase the volume of the electric current, the same results will ensue, since it must follow that any variation in the current strength will cause a variation in the magnetic field about a conductor. Thus, whether a spiral have one thousand turns and a current of one-tenth of an ampere, or if the spiral have one hundred turns and a current of one ampere, the magnetic flux is the same. Multiplying the turns of the spirals by the current strength, in each case the product is the same, viz., one hundred ampere turns.

This explains the meaning of the term "ampere turns," which, as will be seen, affords a convenient basis of comparison for spirals of various windings. Indirectly, it also shows why a spiral wound for one set of conditions may not be used for a different purpose. Thus, if a spiral consisted of many turns of fine wire, it would offer too great a resistance to the passage of a large current, and would result in the current heating the conductor to a degree sufficient to burn out the insulation. While, on the other hand, a spiral of a few turns of coarse wire would not afford a sufficient number of "ampere turns" with a current smaller than it was designed to carry.



TESTING ELECTRIC MOTORS AT SCHENECTADY.

Testing Electric Motors.

When an engine builder sets out to test a 100 horse-power engine, he has to provide 100 horse-power of steam behind it, and 100 horse-power of brake in front of it—the power developed being wasted in the process. To such a man, the system of testing electric motors, by which only 10 per cent. or so of the power developed is actually supplied or wasted, is of peculiar interest.

It is well known that a motor or dynamo is capable of being made to reverse its function at will—the motor acting as a dynamo or the dynamo as a motor. This property is made use of in the process to be described. The method is to gear two motors together—one of them being reversed in function, to act as a dynamo. The motor thus supplies the power for driving the dynamo, while the dynamo supplies the current for operating the motor. The operation is at first sight suggestive of the problem now going the rounds of the press, namely: If two snakes proceed to swallow one another's tails, what will be the result?

Like so many properties of the electric current, the matter is best explained by drawing a comparison with water. The comparison in this case is with a water-wheel driving a pump—the pump, in turn, delivering its discharge to the head race of the wheel. With such an arrangement, it is obvious that if sufficient water were supplied to the wheel from an outside source, to make up the loss of effect due to the lack of perfect efficiency of the wheel and pump, the apparatus would work indefinitely, the power supplied and wasted being represented by the water supplied, while the actual power developed would be the full power of the wheel. It is precisely so with the electric arrangement. Owing to mechanical and electric losses, the dynamo does not supply enough current to operate the motor; but if this deficiency be made up, the apparatus will operate. If these losses aggregate say, 10 per cent., the net result is the operation and testing of 100

horse-power of machinery by an actual expenditure of 10 horse-power.

By the courtesy of the General Electric Co., we are enabled to present herewith an illustration made from a photograph of the rig used for testing street-car motors at the Schenectady Works. Two motors, with their cast-iron casings, will be seen geared to the same shaft. The one upon the left is adjusted to act as a dynamo—the one upon the right acting as a motor. Through the shaft and gearing the motor drives the dynamo, while the current from the dynamo operates the motor through the connections shown—this current being reinforced by a comparatively small outside current supplied through the connections shown coming up through the floor.

It will be of interest to know that the motors shown are those supplied to the Manhattan & Lake Side Elevated Road of Chicago, and to the Nantasket division of the New York, New Haven & Hartford Railroad.

The extent to which the apparatus is used at Schenectady may be judged from the number of testing stands seen in the background.

The operation of this apparatus, especially when the horse-power developed runs up into the hundreds, is one which requires nerve, coolness and quick judgment. We expect to publish shortly some practical notes covering this ground, from a gentleman of wide experience in this and similar work.

Electrical Tests of Power Required to Drive Machine Tools.

It is probable that during the brief period that machine tools have been operated by electric motors, more data have been collected regarding the power required for operating such tools than during all the time preceding. This arises from two causes: First, with belt driving, the power consumed by an individual tool is of comparatively little moment. Ample, and even surplus power, entails but trifling increase of cost to the builder, and no purchaser would object to providing any belt which the builder might call for. On the other hand, a deficiency in belt power usually involves but a small expense in providing larger pulleys. About all we care to know about the power required by a belt-driven tool, is if the belt capacity is sufficient. Secondly, the means of measuring such power are seldom at hand, and if at hand, their application would involve considerable trouble and expense. With electric driving, these reasons no longer hold. Motors cost money, and an unnecessary increase in their size involves a corresponding unnecessary increase in the cost; while a deficiency leads, naturally, to an overworked motor and a burned-out armature. Then, too, the measurement of electric power is the simplest of operations. Ampere meters and voltmeters are everyday pieces of apparatus with the electrician; and their application to motors involves no more trouble or expense than the insertion of the wires in the binding posts, when they are read as easily as pressure gages, and by simple arithmetic their readings are translated into horse-powers. It will thus be seen that the application of motors to machine tools involves the necessity of knowing the power to be developed, while it supplies the means of readily measuring that power.

In the extensive application of electric motors to the operation of machine tools at the Baldwin Locomotive Works, which have been described in these columns, the necessity for this knowledge became at once apparent, and many measurements have been made. By the courtesy of Messrs. Vauclain and Halsey, of the Baldwin Works, we are enabled to lay before our readers, herewith, the most valuable of the data so accumulated. It is a common thing to hear the remark made that machine tools consume but little power, and we expect that the first feeling of our readers will be one of surprise and incredulity at the amount of power which these tables show to be actually used. One or two remarks should, however, be made on this subject: First, locomotive shops are well known to work their tools to their full capacity, and to this rule the Baldwin shops are certainly no exception, the chips made being such as would astonish many mechanics; secondly, many special locomotive tools are arranged to carry two cutting tools, thus doubling the power required; thirdly, all measurements of power by the electric current include the power necessary to drive the motor as a machine, and the loss of power due to the motor not having a perfect electric efficiency. Belts intervene between the motor and the tool; and the power consumed is increased by these losses over what would be found if the power carried by the belts, and actually consumed by the tool, were measured. In the aggregate, these losses are no more, in fact are less, than would be incurred in getting the power to the tool through belting and shafting; but the point is, that these transmission losses are included in this method of measuring the power, while they would not be included if the power consumed were measured by a dynamometer applied to the countershaft. The power determinations found in this way, then, include the power required to drive the tool proper, the power required to turn the motor, and the electric losses of the motor. This fact is stated in order to give a clear understanding of the facts; but it should be understood that these losses are small—the efficiency of motors of the sizes here involved, between electric current and belt may, however, be gathered in a general way from the readings in which the current required by the motor alone, or by the motor and countershaft, were taken. For the motor only compared with the total when taking the heaviest loads (omitting the loads at starting, which are but momentary), the percentage absorbed by the motor ranges from less than 6 in the case of the cylinder boring machines, to 22 in the case of the first slotter, the average being a trifle less than 12. For the two readings of motor and countershaft together, the percentages are 19.5 and 22.4, giving an average of closely 21. In the case of the boring machines, the comparison is between the motor only and the total load, including shafting, as in this case the shaft was a line shaft driving several tools, and not a countershaft belonging to one tool. This question is of interest, as showing the efficiency of the motors, and for a clear understanding of the facts, but it has no other practical import, as will be seen from what follows.

The power being determined by the current readings, it follows that the electric unit of power—the kilowatt—naturally becomes the unit of power before the mind. We are no longer concerned with horse-power as such, except for the fact that the horse-power is to most a much more familiar unit than the kilowatt; and to those unfamiliar with the kilowatt, the amount of power becomes more tangible and is more readily grasped when expressed in horse-powers. To the electrician, however, this does not apply. He soon becomes as familiar with the kilowatt as with the horse-power. He measures the power in kilowatts and thinks in kilowatts, and in his mind the horse-power, as a unit, drops largely out of sight. It hence becomes natural to him to measure motor capacities by the kilowatts of current supplied, rather than by the mechanical power delivered. The effect of this system of measurement is practically to make the motor part of the machine to be driven, as the power measured is that delivered to the motor, and not to the tool. We are no longer concerned with the power required by the tool itself, but with the current supplied to the motor. This measurement of the power in electric units at the motors, goes back through the entire system. The sum of the kilowatts required for the different tools, plus the losses in the conductors, gives the kilowatts capacity required in the generator. It is not until this point is reached, and it becomes necessary to determine the size of engine and boiler required to drive the generator, that the electrician begins to think of horse-powers at all.

In all the tables, A gives the reading of the ammeter and V the voltmeter. H.-P. gives the horse-power as calculated from the readings. In the case of the cranes a fourth column is added, giving in some cases the percentage of efficiency for motors and mechanism combined.

CRANES.

Ten-Ton Overhead Traveler.

	A.	V.	H.P.	Eff. %
Lifting 22,085 lbs. at 10 ft. per min.	50	220	14.7	45
Lifting 10,210 lbs. at 20 ft. per min.	42	220	12.4	50
Lifting 10,210 lbs at 20 ft. per min. And traversing trolley at 200 ft. per min.	45	220	13.3	....
Lifting 6,085 lbs. at 40 ft. per min.	58	210	16.3	45
Lifting 6,085 lbs. at 40 ft. per min. And traversing trolley 200 ft. per min.	68	230	20.9	....

Ten-Ton Jib Crane—Empty.

	A.	V.	H.P.	Eff. %
Running motor and machinery only—clutches open	4	227	1.2	....
Rotating crane	6	226	1.8	....
Traversing trolley	5	226	1.5	....
Raising hook 40 ft. per min.	20	218	5.8	....
Lowering hook 40 ft. per min.	10	222	3.	....
Raising hook 10 ft. per min	8	224	2.4	....
Lowering hook 10 ft. per min.	5	226	1.5	....
Loaded with 7.23 Tons.				
Raising load 10 ft. per min.	40	208	11.1	39
Lowering load 10 ft. per min.	10	224	3.	....
Traversing trolley	20	218	5.8	....
Rotating crane	8	224	2.4	....
Loaded with 9.43 Tons.				
Raising load 10 ft. per min.	48	204	13.	44
Lowering load 10 ft. per min.	7	226	2.1	....
Traversing trolley	24	218	7.	....
Rotating crane	8	220	2.3	....

Six-Ton Jib Crane—Empty.

	A.	V.	H.P.
Running motor and machinery only—clutches open	4	228	1.2
Raising hook	12	222	3.5
Lowering hook	5	228	1.5
Traversing trolley	5	228	1.5
Rotating crane	7	224	2.1
Loaded with 11,800 Pounds.			
Raising load	42	206	11.6
Lowering load	10	224	3.
Traversing trolley	18	219	5.3
Rotating crane	8	226	2.4

Five-Ton Traveling Crane—Empty.

	A.	V.	H.P.	Eff. %
Motor only	4	250	1.3	....
Motor with clutches	6	250	2.	....
Bridge—starting	40	250	13.3	....
Bridge—running 300 ft. per min.	19	250	6.4	....
Traversing trolley	8	250	2.7	....
Raising hook	9	250	3.	....
Lowering hook	8	250	2.7	....
Loaded with 8,500 Pounds.				
Lifting at 8 ft. per min	32	230	9.9	48
Lowering at 8 ft. per min.	13	250	4.4	....
Traversing trolley	10	260	3.4	....
Bridge—starting	60	260	20.8	....
Bridge—running 300 ft. per min.	20	230	6.2	....

WHEEL LATHES.

Two wheels on axle; one tool to each wheel in all cases. Current measured when turning cast-iron centers, the power required being greater with centers than with tires, on account of heavier cut:

Eighty-four-inch Swing Lathe, Turning Large Wheel Centers.

	A.	V.	H.P.
Light cut	10	220	2.9
Extreme cut	27	218	7.9
Average cut			6.1

Another 84-inch Swing Lathe, Turning 32-inch Centers.

	A.	V.	H.P.
Cut ½ in. deep, feed ⅛ in.	13	238	4.2
Cut ½ in. deep, feed ⅛ in. again	16	220	4.7
Cut ½ in. deep, feed ⅜ in.	16	240	5.2
Cut ½ in. deep, feed ⅜ in. again	17	237	5.4
Cut ½ in. deep, feed ⅛ in.	19	228	5.8

Another 84-inch Swing Lathe, Turning 56-inch Centers.

	A.	V.	H.P.
No cut	5	230	1.5
Heavy cut on rim	18	218	5.3
Heavy cut on rim again	20	220	5.9
Heavy cut on rim again	20	230	6.2

HORIZONTAL BORING MILLS.

Boring hubs of 56-inch driving-wheel centers, using single lathe pattern boring tool—not a boring head:

Seventy-eight-inch Swing, Light Pattern.

	A.	V.	H.P.
Boring hole 67⅛ in. dia., heavy cut	14	232	4.3
Boring hole 67⅛ in. dia., heavy cut again	15	234	4.7

Another 78-inch Swing, Very Heavy Pattern. (Same work as last.)

	A.	V.	H.P.
Boring hole 67⅛ in. dia.	22	230	6.8
Boring hole 67⅛ in. dia. again	23	232	7.1
Facing hub	17	240	5.5
Facing hub, cut ½ in. deep	20	238	6.4

This mill often takes still heavier cuts.

LOCOMOTIVE FRAME SLOTTING MACHINES.

These machines have two heads with a tool to each. Independent motor to each head. The readings are for one motor.

Crank motion machine with quick reverse; stroke, 8 inches; material, wrought iron:

	A.	V.	H.P.
Motor only	7	240	2.3
Motor and empty machine	10	225	3.
Heavy cut	28	220	8.3
Heavy cut again	35	220	10.3

The last reading slipped the belt.

Planer motion machine with dogs and shifting belt. Two heads, as before, but motor to each head. Readings for one motor:

	A.	V.	H.P.
Motor only	7	240	2.3
Heavy cut	40	220	11.8
Heavy cut again	35	225	10.5
Empty machine at moment of reversing	50	230	15.4

The cut requiring 11.8 horse-power slipped the belt.

Ordinary machine shop pattern of slotter with goose-neck frame, crank motion; 36-inch table with capacity up to 12-inch stroke. Cutting wrought iron:

	A.	V.	H.P.
Motor and counter-shaft	5	224	1.5
Slotter, empty	5	230	1.5
12-inch stroke	15	220	4.4
8-inch stroke	15	218	4.4
8-inch stroke again	20	188	5.
4-inch stroke	20	224	6.
4-inch stroke again	24	208	6.7

Cuts are the heaviest belt would pull. All the above slotting machine readings are presumably for the cutting stroke only.

PLANERS.

Seller's new quick-return planer; return 4 to 1; 62 inches between housings; to plane 35 feet long. Material, wrought iron (locomotive frames):

	A.	V.	H.P.
Motor only	7	240	2.3
Motor and counter-shaft	15	220	4.4
Empty table forward	35	235	11.
Empty table backward	40	220	11.8
Empty table at moment of reversing	60	210	17.
Empty table at moment of reversing again	63	220	18.6
Cut 5/8 in. deep, ¼ in. feed, 2 heads, 2 tools	70	220	20.6
Cut 5/8 in. deep, ¼ in. feed, 2 heads, 2 tools again	75	215	21.6

Seller's standard style machine; 62 inches between housings; 35 feet long. Material, wrought iron (locomotive frames):

	A.	V.	H.P.
Empty table forward	15	250	5.
Empty table backward	20	250	6.7
Empty table at moment of reversing	140-150	250	47-50
Cut 5/8 in. deep, ¼ in. wide, 2 heads, 2 tools	70-80	245	23-26

Another machine, three feet between housings, 12-foot table. Material, wrought iron:

	A.	V.	H.P.
Motor and countershast	10	200	2.7
Empty table forward	12	210	3.4
Empty table backward	10	190	2.5*
Empty table at moment of reverse.	40	200	10.7
Cut 1 tool	25	220	7.4
Cut 2 tools	49	210	13.8
Cut 2 tools again	39	216	11.3

Cuts not as heavy as machine should take.

CYLINDER-BORING MACHINE.

Motor connected to one-line shaft, which drives several machines. All work on 18-inch locomotive cylinders:

	A.	V.	H.P.
Motor only	6	220	1.8
Motor and shafting			6.4
Single machine boring, roughing cut about ½ in. deep, ⅛ in. feed	70	190	18.
Deduct for motor and line shaft leaving			12.
Facing flanges, 2 tools, heavy cut	100	190	25.5
Deduct for motor and line shaft leaving			19.5
Another machine, facing flanges, 2 tools	100	240	32.
Deduct for motor and line shaft leaving			26.
Both machines boring, average cut	115	200	31.
Deduct for motor and line shaft leaving			25.

It will be understood that the motor selected for any given tool is one having a capacity equal to the heaviest duty of the tool in question. No tool is worked continuously at this heaviest duty; and, of course, all tools have idle periods. It becomes of immediate interest to know the ratio between the power capacity of all the motors and the capacity of generator necessary to supply current for average working. In the case of the Baldwin Works, the total capacity of the motors fitted to the tools (not including the cranes) is, closely, 200 horse-power. The capacity of the generator which supplies current for these motors is 100 horse-power, and the actual output of the generator is, ordinarily, 80 horse-power.

* There appears to be an error in this figure. The power required to drive the machine must, of course, exceed that required for the motor and countershaft without the machine, and the power required to drive the empty table backward should exceed that required to drive it forward.

LETTERS FROM PRACTICAL MEN.

Case-Hardening the Parts of the Condensed Engine.

Editor American Machinist:

It seems that the case-hardening of steel and iron is just now a subject of very general interest to the readers of the "American Machinist." I have often found in the pages devoted to information on such topics, the answer to questions I had very much desired to ask.

In the construction of the little marine engine of which you have a photo and description, I had some experience in the line of case-hardening, most of the visible working parts in that machine being case-hardened and finished by grinding. Perhaps, if you could gather anything of value from my description of the purpose and performance of the engine, you might also find of interest a brief account of the materials and methods used in its construction.

Wishing to build of good material such parts as might be subjected to not exactly known stresses, I boldly asked questions of men I believed could give me the desired information. Mr. E. Rivett, of the Faneuil Watch Tool Co., kindly interested himself in my efforts, and procured for me a forging of Lowmoor iron for the main shaft and crank pin. The three eccentrics journaled on the crank pin are also forged from the same metal, the crossheads are of mild steel; the slideways are of Sanderson tool steel, pinned and brazed to the segments which support them; the bearing surfaces of the slides were bored concave from the center line. They were hardened and then bolted in position, and the concaves ground true with an extension lap mounted on a mandrel, which was kept true to the axis of the piston movement.

Mr. Rivett posted me as to about how much I might expect the Lowmoor iron parts to change form in the hardening process, and I machined them accordingly, after which he had them hardened. The shaft was somewhat sprung, though not seriously. I think it might have been prevented at the forge by a good heavy end hammering, to release internal strains after the forging to shape was finished.

These parts I afterward finished over their entire bearing and plain surfaces by grinding. Where necessary to work into square corners, brass laps, charged with diamond powder, were used. This diamond-charged lap is a tool of good efficiency, which is neither very expensive nor difficult to make.

In regard to case-hardening iron, I learned from an experienced workman upon gun parts, that while the open-fire treatment with cyanide potassium will put the veriest skin upon the surface, that is about all that may be expected. If it does much more than that with machinery steel, it will be because the stock is good enough steel to take it. He told me he had hardened clear through thousands of light gun trimmings, drop-forged from Norwegian or Swedish iron, by packing in a box with bone dust and leather scrap; that it was more difficult to harden any stock of considerable size deep enough to stand the removal of much of the skin, without grinding through to the soft metal. I found these engine parts sent East, hardened to a depth of from $\frac{1}{64}$ to $\frac{1}{32}$ of an inch, for I had to grind through the skin to get a drill into the soft metal in the backs of the eccentrics, to remove a sufficient amount of the metal to roughly balance them. It is easy to anneal or draw any part of a case-hardened piece with a blow-pipe. I believe iron is better than steel for some parts, and I never found any surface of this Lowmoor iron, after grinding, that I could cut with a file. There seems to be a belief among mechanics that hardened bearing surfaces will not run well together without cutting. There are others who think differently. I have given this engine gear some hard usage, and the contacts between bearing surfaces have a high polish and seem to improve with use.

FRANK CAREY.

Penn Yan, N. Y.

"Testing an Injector."

Editor American Machinist:

I see in your issue of January 23d, an account of testing an injector as to its capacity under various lifts. It is true that some injectors will work to a somewhat greater capacity if the feed water is supplied under pressure, but many will not work so at all, while non-lifting injectors will work only on a water supply. It is true with many injectors, that with a favorable water temperature they will work to a greater capacity than with either warmer or colder water.

Generally, injectors which will work on considerable lifts will not bear a supply pressure, and vice versa.

The actual capacity of fixed-tube types of injectors is largely controlled by the inlet throat area between the tip end of steam jet and mouth of combining tube.

Often a fixed-tube injector may be increased in capacity by enlarging the throat area, either by filing down the end of steam jet or enlarging mouth of combining or lifting tube, or withdrawing steam jet back from combining or lifting tubes, which should be done very gradually and with frequent tests, or the injector may be spoiled. This only makes it "take more water" up to its "working capacity," which also may sometimes be improved by slightly enlarging the steam jet when much less than 1½ times diameter of the delivery tube, or slightly enlarging delivery tube when less than two-thirds of the steam jet; "slightly," however, does not mean a machinist's thirty-second, but an actual quarter of a sixty-fourth, or one number of twist drill at a time.

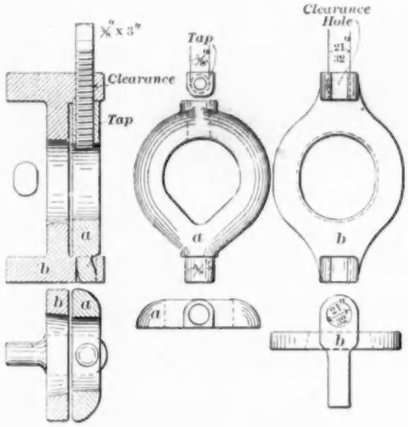
It is true that most injectors are not "capacitied" strictly according to list, many being 10 to 50 per cent. below, while some are even 50 to 100 per cent. above the list.

The foregoing facts are true for fixed-tube double jet, single jet and automatic types, but less true of adjustable and self-adjusting types.

The working capacity depends principally upon the size and proportional area of steam jet, combining tube and delivery tube; also upon length, form and manner of mounting, which would require too long a description for this article.

F. R. WILLIAMS.

Buffalo, N. Y.



An Equalizing Lathe Dog.

Editor American Machinist:

The article by Frank Richards, in the October 24th issue, entitled, "How Long Shall the Tail Continue to Wag the Dog," has prompted me to resurrect the inclosed sketch of an equalizing dog that I made a few years ago. Two were made and put in use, but the shop did not call for any more of them, and dog manufacturers whose attention was called to the device did not seem to think that there was any demand for it; so the presumption is, that if the tail is to continue to wag the dog, one tail is considered to be equal to the labor involved.

E. D. MACKINTOSH.

Steaming Values of Coals.

Editor American Machinist:

When the war was over, and the price of wages was getting lower, there was a big strike in the anthracite coal regions that compelled steam-users to use the soft coals; and from this compulsion they learned that these coals were much cheaper and more work could be done with them.

In some localities it has been figured out that one dollar per ton more can be paid for soft coal than for buckwheat anthracite, that is usually sold for steam purposes.

If buckwheat was worth $2.75 per ton, then soft coal could be used until the price reached $3.75, when it would be economical to use buckwheat. There is, however, a vast difference in the heating values of soft coals—much more so than in the anthracites. This is too often lost sight of by many purchasers when buying coal, and they take too much for granted, assuming that because soft coal has more heating value, therefore all soft coals must have this extra heat, and so buy the coal that is offered cheapest.

Some years ago the writer was engineer of a set of boilers, where it was his practice to make a test of every grade of coal that was bought; and from those tests the price that could be paid for any kind of coal was determined. Having these fig-

Coal.	Pressure of Steam by Gauge.	Temperature of Feed Water.	Pounds of Coal per Square Foot of Grate.	Per Cent. Ash.	Pounds of Water per Pound of Coal, Actual.	Pounds of Water per Pound of Coal, Water 212°, to Steam 212°.	Pounds of Water from and at 212° per Pound of Combustible.	H. P. Steam 70 Pounds, 70° Pounds Water per Hour.
Egg	60	42	13.2	13.5	7.60	9.15	10.48	70.25
Pea	65	96	13.7	15.8	7.97	9.13	10.85	70.40
Clearfield, spread even	63	84.8	12.2	5.68	8.48	9.81	10.40	69.80
Clearfield, coked	63	84.6	12.2	5.7	9.15	10.63	11.15	76
Clearfield, wet, coked	68	73	13	6.09	8.45	9.90	10.54	73
Elk Garden, coked	66	97.3	11.48	6	9.13	10.46	11.16	70
Clearfield and dust, 50%	68	72	14.2	9.28	8.63	10.12	11.16	83
Reynoldsville	65	73.9	13.9	15.33	7.79	9.11	10.75	*69.74
Pocohontas	64	62	9	5.5	9.06	10.70	11.35	*54.3
Georges Creek	64	69.4	11.23	5.97	9.23	10.84	11.51	*63

*Last three, h.p. from 70° to 70 pounds steam.

ures on hand, the owners could tell, from bids handed in by coal dealers, the kind of coal they could buy.

A table is appended, showing some of these figures. The value of the coal was determined from the column, "Pounds of Water per Pound of Coal, Water 212°, to Steam 212°." This included the ash, and is an important item, as this has to be paid for at the same price as coal. It will be seen by the table that in some cases, where a pound of combustible shows more work than a pound of coal, yet that grade of coal was not the cheapest, as not as much work was done with the coal, including the ash, which is the real item that costs.

It will also be noticed that different ways of firing had an important bearing on the result. Clearfield was tried first by firing medium light, and the coal spread evenly over the grates, care being taken that no holes came in the fire. Now, with the soft coals there is a large amount of volatile matter of great heat value that is lost when coal is fired this way; so the next thing tried was to see if some of this could be saved. A test was then made by carrying the fires medium heavy, keeping one side covered so that it would coke slowly; then when the other side needed replenishing, break up this coke with a heavy steel bar and cover the other side the same way. By this method the volatile products were distilled so slowly that there was ample time, and heat, to burn them. The result can be seen in the two tests of Clearfield, going from an evaporation of 9.81 when spread over even, up to 10.63 when coked.

All the other tests were with coking fires. When coal is wet it will coke better and make a hotter fire; and for this reason it is often insisted upon that it is of advantage to wet the coal. All these tests have been corrected to dry coal, and the test with wet coal was made by weighing the coal dry and then wetting it in the usual way. The result is seen by the evaporation falling off to 9.90, about the same as the lighter fires, but having the benefit of the coking fire.

Soft coal and dust show well, and the ash is much less than would be anticipated.

Gas coals have too much volatile matter to be taken care of in an ordinary furnace, and would smoke and smudge everything.

These tests were made with a Harrison boiler, under the old rating of horse-power. These boilers are placed well away from the fire—a point that could be observed to advantage by other builders. The same grates were used that came with the boilers in all the tests.

Waterbury, Conn. W. E. CRANE.

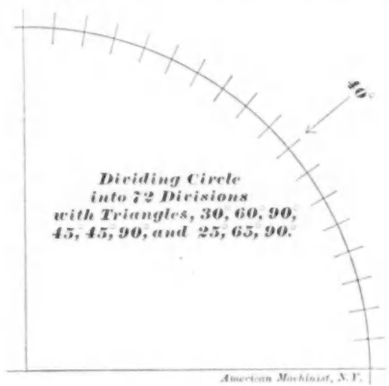
Dividing Circles with Triangles.

Editor American Machinist:

In your issue of January 23d, Mr. Tecumseh Swift writes under the heading of "A Third Triangle for Draftsmen." After speaking of the two standard triangles, and of their indispensable value to the draftsman, he says: "Every draftsman does not know that the addition of a third one would enable him to divide the circle into 72 divisions," etc. And in closing, two questions are asked, viz: "Who knows of, or is using the third triangle?"

Like "Topsey," I had to "'fess" something; and I may as well "'fess" the truth and say, that up to the time of reading Mr. Swift's article, anything of a third standard was strange to me. Since then I find that one of 25, 65 and 90 degrees, in combination with the other two, enables us to divide the circle in the above-named number of divisions, a quadrant of which I have divided by this method and inclose with this.

There is a question in my mind if the



Dividing Circle into 72 Divisions with Triangles, 30, 60, 90, 45, 45, 90, and 25, 65, 90.

draftsman, occupied with making machine-shop drawings would find it of much use. True, I only make occasional drawings, and most of these are "detail," and therefore may not be capable of judging.

In my own practice I find it very convenient sometimes to make a special triangle for the work then in hand. For instance, a little while ago I had to make patterns for steam pipes and branch pipe for locomotives. I had to get my measurements from the "front end," which, to say the least, was not very convenient. The cylinders were in place, and had angular seats to steam openings where the steam pipes connect. I found the angles of the same in the following way:

A piece of board with a straight edge, and long enough to reach from about the middle of one to the same on the other, with its straight edge resting on the inside edges of opening; then a parallel straight edge laid on the face of seats enabled me to draw lines on the board which gave the angles in relation to the horizon; or, in other words, the bottom edge of board and the lines drawn across its face, as given by the upper edge of parallel, give the angles, which, if cylinders are right, will be found to be both sides alike.

It was very easy then to lay the edge of a thin piece of board so that it coincided with the line on board; and by drawing a line on it coincident with the edge, we have our triangle, with the exception of squaring off the end. That done, I found it very handy when making the working drawings for the patterns. With its aid I could easily draw the flange joint and edges of same, without a combination of other triangles.

Now to refer to the inclosed sketch of quadrant, divided into eighteen parts. I had to combine all three to make some of the angles; or, which amounts to the same thing, their supplements. For instance, take the angle of 40 degrees, using the edge of T-square for zero line. I had to have 45 degrees of one, 30 degrees of the second, and 65 degrees of the third triangles, and I think to have to hold three triangles and T-square in place with one hand is a little too much.

No; if I have to divide a circle into any number that the "standards" will not do, I will keep to the use of trigonometrical lines and degrees to give me the chordal pitch, and step it off with dividers.

In closing, would say that it is very rare that the dividers will space it off exact, the first time going round. Now, suppose we are dividing a circle into 50 divisions, and when we come around to the starting-point it is found to lack just $\frac{1}{4}$ inch of being right; then $\frac{1}{50} \times \frac{1}{4} = \frac{1}{200}$ inch—a very small amount—and the best way to make the correction is to take your sharpening slip and hone the inside of your divider points just a few strokes, then try again; only not start from the same point, or if you do, go around in the opposite direction, or else your dividers will ride over into the old marks.

WM. NEWTON.

Oneonta, N. Y.

The "Mossback" and His Opposite.

Editor American Machinist:

There is a very appropriate name for him who never gets any new ideas and gradually gets to be a worse mechanic than he was originally; it is the "Mossback." He it is who never can see anything good in anything that is new; and sometimes he goes so far as to fail to see anything new in anything that is good. He potters along, year after year, prating of the good old days, and lamenting that so many men about him are forsaking the tried and the true for wild and unknown methods and appliances. He has an old slide-valve engine that cuts off at about eleven-tenths stroke; his boiler is a mass of soft patches; his belts are pieced to a degree that reflects credit only on his patience and perseverance; his tools are antiquated; and in ten years he has not done a job of work that any decent mechanic would allow his name to be mentioned in connection with. There is no use in trying to reform such a man; his mental make-up corresponds with that

which, in religious matters, the Roman Catholics call "the state of invincible ignorance." Verily, "Ephraim is joined to his idols."

But then there is the other man across the street, who is Ephraim's exact opposite. Since the day when he was first able to have a say about matters mechanical, he has ever decried the old and watched for something better. Everything new that comes out he is willing to take and try; not merely try it at the inventor's expense, but buy it out-and-out, and take down and throw out the old one; so that his shop (if he has one) is ever in a state of change—it is like perpetual moving-day, or house-cleaning, or something like that. The more contraptions the machine has on it, the better he likes it. The greater the difference between its principles and that of the corresponding machine which he has, the more he wants it. He aims to be considered "progressive;" but really the only thing in which he succeeds in progressing is in getting older. Ten to one he will be buried in a patent coffin with special ventilating appliances, and under a tombstone which is set so as to act as a sundial, or which has its edges due north and south, or has a hole drilled through it by which the true position of the pole-star may be ascertained, or something like that. Meanwhile, being alive (very much alive, he flatters himself), he is the delight and the profit of the sales-agent. The man with a feed heater warranted to superheat the feed water with exhaust steam to a degree higher than the temperature of the live steam; the fiend with the lubricating oil which costs only four cents a gallon and is guaranteed better than the best winter-strained lard oil; the agent with the non-burnable steel, and the genteel traveler selling a boiler covering that enables the use of cinders for fuel—all these are the light of his eyes and the joy of his heart—and he is their meat. G.

Method of Setting Angle Plate.

Editor American Machinist:

I had a few small bearings to bore, as shown in Fig. 2, the shaft hole to be the same distance above the bottom face in all the bearings; and, of course, the most natural way was to clamp them on an angle plate bolted to face plate of lathe. But as there was some probability that a few more would have to be bored out in the future to exactly the same height, I wanted to devise some simple scheme by which the angle plate could, at any time, be located at exactly the same distance off center with ease and certainty.

I thought of several ways of doing this; but the one I finally adopted is shown in Fig. 1. The only thing necessary to make specially for the job in hand was the gage *A*, the length of which is twice the distance of shaft hole from bottom of bearing. In this particular case I wanted the angle plate .41 inch off center; so the gage *A* was made .82 inch long. *A* is simply a round rod with a hole bored lengthwise, large enough to admit the screw, and then put on an arbor, and the ends faced parallel and to the given length. *B* is any plate, either round or square, that has at least one side machined flat, this side being placed next to *A*, and a screw passed through *B* and *A* to fasten them both to angle plate, as shown in Fig. 1. Then the angle plate was shifted on face plate till the two surfaces *C* and *D* were both the same distance off center, which was easily accomplished with the hole indicator I showed in your issue of August 15th, 1895.

The unfortunate machinist who is not the proud possessor of a lathe indicator of some sort could use an ordinary boring tool, with a piece of paper or sheet metal, as a feeler between it and the surfaces *C* and *D*, to determine which of the two was

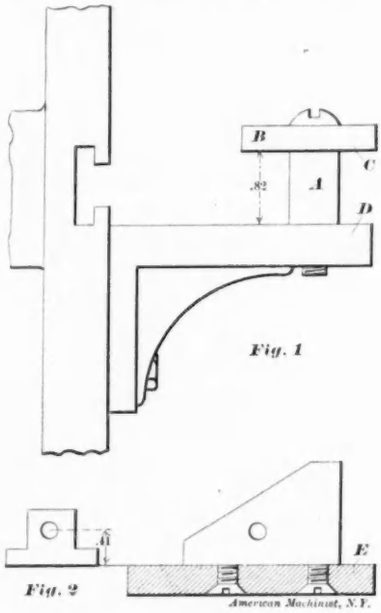


Fig. 1

Fig. 2

American Machinist, N.Y.

Fig. 3

METHOD OF SETTING AN ANGLE PLATE.

nearer the center. Men in electrical shops sometimes have a bell and battery at their command, in which case an insulated wire might be fastened in the tool post, and the contact tried at *C* and *D* as the lathe was rotated and the cross-slide fed slowly out; the bell would ring first when the wire was in contact with the surface that was nearer the center. This is only a suggestion, though, and I am afraid I am encroaching on the territory of the man who runs the electrical department of the paper.

One of the pieces in which I had to bore a shaft hole (Fig. 3) was of an awkward shape to clamp down; but as it had two screw holes already tapped in the bottom, I screwed it fast to a parallel plate *E*, and then clamped *E* on the angle plate. In setting the angle plate for this piece, *E* was placed between the gage *A* and the angle plate, and the contact tried at the inner surfaces of *B* and *E*.

WALTER GRIBBEN.

Brooklyn, N. Y.

Wanted—A Situation.

Editor American Machinist:

In a New York paper a few days ago I read the following: "Wanted—Engineer, machinist; pipe-fitting, firing and repairs, Corliss engine, ice machines and dynamo; moderate wages." Let us analyze this, as the parson analyzes his text, and see what it means:

First, he claims to be an engineer, which term is rather indefinite at the present time; but in this connection it is taken as meaning a steam engineer. This implies knowledge of a great many different things; and if his claim is well founded, it has taken years of study, research, experiment and labor to complete this theoretical and practical education. Second, we note that he is a machinist, which is a trade that requires several years to learn, and much practice to bring to perfection. A man may know how to run a lathe and planer on certain kinds of work, and still not be a machinist. Third, he is a pipe-fitter, and so, I suppose, can do all his own piping, making it unnecessary to hire a man to do such work, as is customary in such cases. Fourth, he knows how to do his own firing and make his own repairs. The statement that he can do these things means that he will do them, as I understand it; so that he evidently intends to be at work at least a large portion of the time. Much repair work must be done during the night; so we are inclined to wonder when he will rest. Fifth, he understands the Corliss engine, which is quite a modest statement when we consider that he has already claimed to be an engineer. Furthermore, as this is one of the most common types of engines now in use, a man who does not understand it cannot claim to be a thoroughly posted engineer. Sixth, he can take charge of ice machinery, which also covers refrigerating machinery, the operation of which requires a clear head, good judgment and more or less experience, in order to be successful. Seventh, he can care for and run dynamos, which is a trade by which many men now earn a living, and usually considered sufficient to keep a man busy. Here we have a man who claims to understand all of these trades, and is willing to work at them, provided he is given the chance. This is somewhat surprising; but when we learn that he is willing to do it all for moderate wages, we are astonished.

If all of this is to be done for low wages, who can get high wages? Again, what would justly be considered moderate wages in such a case? If we figure it on the basis of what a fireman should receive, calling it $2 per day; then, as he masters

seven different occupations, he should have at least $14 per day, or $4,368 per year, not including Sundays. Perhaps the proprietor would not call this moderate wages, and so a difference of opinion would arise at once.

We are living in a fast age and in a time of great possibilities; but perhaps a man can undertake to do too many things, and so do none of them well. If this is true, then is it not only fair to assume that this advertiser may come under that head?

Engineers frequently complain of the way in which they are required to work; but if other members of the craft voluntarily agree to do so much, who can blame some short-sighted and inexperienced steam-user for taking up their proposition? The facts in the case are, that men who are out of employment will sometimes promise to do more than their own best judgment tells them they can do well, in an effort to secure a situation.

W. H. WAKEMAN.

New Haven, Conn.

[While there are many proprietors who are looking for these low-priced all-around "engineers," there is a great temptation to a man out of work to advertise in this way.—Ed.]

A Square Square.

Editor American Machinist:

In your issue of January 16th, 1896, I found the description of Mr. G. A. Bates' "Precision Square" and "Testing Block," which I, as a tool-maker, appreciate very much.

I have tested and used the square and block myself in the shop, known at that time as the Page Compositor Co.'s shop, and I am satisfied that it is a very convenient tool and a square square.

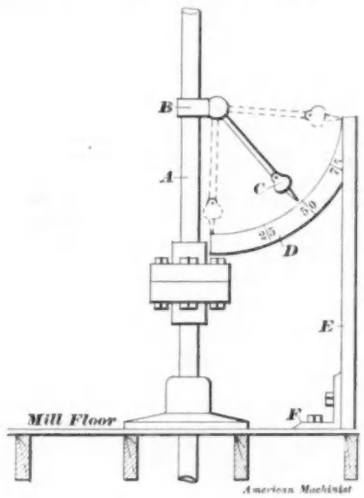
A. R. HENDRICKS,
With Black Mfg. Co., Erie, Pa.

A Simple Speed Indicator.

Editor American Machinist:

Not long ago it fell to my lot to help in the erection of a roller process flouring mill, and as the cleaning and bolting machinery was not driven by the same water wheel which drove the rolls, there was no way provided for ascertaining the proper speed to drive them. A $30 indicator was attached to the power for the rolls, that would ring at the least variation of speed above or below normal; and when the mill was started, the builder said to the miller that the large upright shaft that drove the upstairs part of the mill must be run at 50 revolutions per minute —but how should he know when he was making just 50 revolutions? The builder looked blank, and said that the shaft was marked so on his specification, but how to know exactly when it was doing so was not a matter of his. I looked at the situation for a few minutes, and then made a rude sketch with a pencil of the "Simple Speed Indicator," of which I send you a sketch. It took but a little while to make it; and when completed, it was very much like this sketch.

A is the upright shaft; *B* a clamp collar (wrought), to which was suspended a common brass plumb-bob *C*. The scale *D* is an arc representing 90 degrees of a circle, and is supported by the post *E*, which is fastened to the floor by a cast angle iron and two lag screws *F*. The figures on the scale indicating the proper speed were very large and distinct, so that the miller could, from any part of the room, see at a glance if the speed was right. I have forgotten the dimensions of the different parts, but the sketch should make it plain; and the gradations



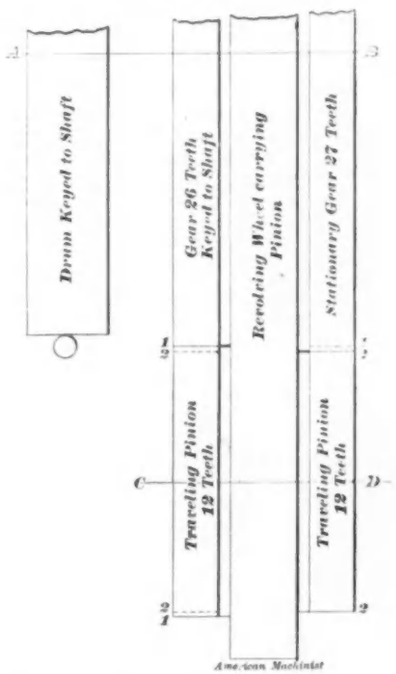
on the scale can be determined by counting, as we did. This indicator has a still larger scope of usefulness, as was afterwards shown, for the mill was run during day time only; and when very dry weather came, the head of water was so low that the mill, though started at the proper speed, would gradually slow down during the entire day, unless more gate was given at intervals. Under these circumstances, it was an easy matter to convert it into an alarm indicator. To accomplish this end, an ordinary bicycle bell was attached to the post below the scale, with wire levers extending up past the scale to where the plumb-bob would strike them and ring the bell if the speed went above or below normal.

R. W. J. STEWART.

Dalton, Ga.

Standard Catalogs.

"The advisability of following the standard sizes for catalogs and industrial publications has frequently been urged in these columns, and yet it seems necessary that the attention of many manufacturers who are publishers of this kind of literature should have the matter brought more forcibly before them. If they could understand how inconvenient are the odd sizes of pamphlets and catalogs about an office where they rapidly accumulate, they undoubtedly would be impressed with the importance of the subject. It has been stated from time to time that catalogs of odd sizes go into the waste basket, but this is evidently not believed by the manufacturers spoken of. While in the office of a superintendent of motive power, a representative of this journal noticed a clerk approach his superior with two catalogs from the mail. One was a very modest affair in paper covers, and the other an elaborate book with a much better binding. The first was standard size, and was placed in a special filing cabinet arranged for the purpose, and the other was 'scrapped' at once with a remark which would convince any one of the advisability of attending to this small detail if they wish their publications to fulfil the office for which they are intended. It is impossible to understand why the standard sizes are so neglected when there can be no possible reason for not following the regularly established dimensions."—"Railway Review."


Drum Keyed to Shaft
Gear 26 Teeth Keyed to Shaft
Reeding Wheel carrying Pinion
Stationary Gear 27 Teeth
Traveling Pinion 12 Teeth
Traveling Pinion 12 Teeth
American Machinist

We trust that our readers have not spent a week's valuable time, or lost a week's sleep, in their quest for the "sketch" alluded to as Fig. 2 in our article upon "A Differential Gear Question," in our last issue. We much regret the omission, and present here the sketch, which, we trust, will render the article intelligible and satisfactory.

Mr. A. Talkman has been elected President of the Engineers' Club of Philadelphia for 1896.

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Associate Editors.

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☞ *We publish nothing in our reading columns for pay, or in consideration of advertising patronage. Space in the advertising pages only is for sale.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

☞ *All communications for or relating to the reading columns should be addressed to the editor. All other communications to the company, as above.*

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Though for over eighteen years the "American Machinist" has been publishing, free of all charge, descriptions of such machinery and tools as were thought to be of interest to its readers, there are still a number of people who seem to think we will publish matter in our reading columns for pay, and write to ask us, how much we will charge.

There are papers, some of them quite pretentious ones, that are humbugging their readers and buncoing other people by taking their money for glaring, but utterly worthless "write ups" of equally worthless contraptions of one kind or another.

This paper never has been, and is not now in that line of business, and we consider such business disreputable.

Power Required to Drive Machine Tools.

In another column will be found a collection of data giving the power required to drive various machine tools at the Baldwin Locomotive Works. If the reader will turn to our issues of April 23, 1891, and April 12, 1894, he will find some similar data, contributed by Prof. J. J. Flather, covering the requirements of similar tools, though mainly of smaller sizes than those here considered.

These latest figures show a far heavier power consumption than the earlier ones, and a much heavier consumption than is usually believed to pertain to such work—so much heavier, in fact, as to stagger belief in their accuracy. As is pointed out in the article itself, measuring power by the current supplied to an electric motor, includes some sources of loss which would not be included if the measurements were made with a dynamometer, and the practice of locomotive works is in many respects peculiar; but after all allowances are made, the fact remains that the consumption here shown is far beyond what is usually believed to be the case.

It is to be noted in this connection that the tests were made by the officers of the locomotive works for their own information in installing motors, and such being the case, no suspicion can attach to their having been other than conscientiously made.

There is a wide-spread lack of information of this kind, and we do not doubt that this contribution to the general fund of knowledge will be considered of interest and value.

The Algebraic Formula Bugbear.

We cannot devote space in the "American Machinist" to an attempt to teach algebra; but have invited an algebraist, who at the same time is a practical man, familiar with files and oil cans, to explain how those who are not algebraists, and never expect to be, can yet readily understand and make use of such formulas as are found in our columns occasionally.

We are aware that we have been criticised for publishing matter containing algebraic formulas; but we think the average practical man over-estimates the difficulties of algebra and under-estimates its value. The difficulty of learning the science from the books is largely due to the method of treatment, which puts a mass of matter, of which the reader can see no value, before the kernel, which comes further along; and the man who attempts to learn the subject from these books, gets discouraged and gives it up before reaching what would be of real value to him. Now, no man who has mastered the slide valve, for example, need be afraid of algebra. Any schoolboy can learn algebra, but it requires a man to fully understand the slide valve. The fact is, that it requires but a small amount of study to enable any one to understand the ordinary run of formulas. They are but a string of letters and signs, the latter being but few in number and easily learned. The same signs make up all formulas, no matter how complicated they may look. A book-keeper's column of figures has a formidable appearance to a child who has just learned addition, and yet the principles which he has learned are all that are required for adding the column. Just so, a long formula has a formidable appearance to the novice in algebra, although it is in reality but a longer strings of signs, of which, in some shorter formula, he would have no fear.

In another column we publish the first of a short series of articles on this subject. This series is intended to assist in dissipating this bugbear, and also to explain more fully the formulas introduced by Mr. Mason in his series on "Electrotechnics."

We hope those of our readers who do not understand the subject, will read these carefully. There is no question of the advantage of algebra. When work becomes at all complicated, it is very difficult to treat it in arithmetical language, the rules becoming so long and involved that it is almost impossible to keep the relationships of the different data in the mind; while they remain clear and distinct when expressed in the abbreviated language which comprises algebra. In fact, the necessity for algebra may be said to begin where arithmetical rules break down. On this account, algebraic language is used more and more by the writers of technical books, which books must be literally sealed books to those who cannot understand their language. We believe that, brief as they are, the articles referred to will go a long way toward making this language plain. Let our non-algebraic friends study them and see.

This formula bugbear has stood in our

way so much that we have determined to do what we can to abolish it, and we will be glad to hear from any of our readers who find in our columns things they fail to understand. We may arrange for the publication of similar articles in the future as their desirability is thus indicated.

In its issue of January 10th, "Engineering," of London, takes up the subject of "American Naval Engineers," and indorses every essential point made by those who are, in this country, contending for decent treatment of those who must manage the machinery of our modern war vessels.

It is declared that Senator Squire's bill is "to give greater powers to the engineer officers of the United States Navy, and put them in a better position to obtain relief from grievances which certainly appear at present to be many and serious." And it then goes on to say that "We know our own naval engineers have much substantial cause for complaint, but beside their brethren of the United States their lot is one greatly to be envied."

The only point upon which dissent is expressed is that which relates to titles, and regarding this our contemporary says: "We think that an engineer who is anxious to change the name of his rank to that of an executive officer, pays his branch of the profession a very poor compliment." On this point we may say that our naval engineers seem to be simply adapting their tactics to conditions as they find them. They are not now so much concerned with the question of compliments, as with the question of whether or not they shall be allowed to remain in the service and live.

The present situation is simply intolerable, and the main struggle is to secure plain rights that ought to have been freely accorded long since, and which "the line" dishonors itself by attempting to withhold. In the midst of such a struggle, questions of appropriateness of titles are naturally likely to be overlooked or disregarded. The fact remains, however, that, considered in the abstract, it would be better if entirely separate and distinct titles could be borne by the naval engineers. Commodore or Rear-Admiral means little to the engineering world.

A Distinguished Honor.

Though Mr. Clarence S. Bement, of Bement, Miles & Co., Philadelphia, is doing important work in connection with a large business, and is a busy man, he finds time to devote to a branch of science in which he is specially interested, and has just been awarded the silver medal, "Bene Merenti," of the Royal Academy of Sciences, at Munich, Germany, for his untiring and distinguished services in advancing the science of mineralogy. As is well known, Mr. Bement has the finest private collection of minerals in the world.

Questions and Answers.

Name and address of writer must accompany every question.

Questions must pertain to our specialties and must be of general interest.

We cannot undertake to answer questions by mail.

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(26) F. B. C. asks: Will there be much, if any, increase in economy in using a compound duplex pump in place of a simple duplex, the steam pressure being only 60 pounds in either case? A.—If the compound pump comprised also a condenser, while the simple pump did not, there would, of course, be a decided economy in using the former. A competent engineer should be consulted in such a case as this, and he should be fully informed as to all the conditions involved.

(27) W. S. S., Rainer, Ala., writes: I want a spring motor to develope about ¼ to½ horse-power, and to run for 5 or 6 hours when wound. I can wind the motor by connection to running machinery. Would it be practicable to build such a machine? What size and style of spring would be required, and where could I get such a spring? A.—The scheme is entirely impracticable. The spring required would be so large, and the reducing mechanism so heavy, that it is not worth while to attempt a computation. Regarding storage batteries, inquiry should be made of some of the electrical companies.

(28) G. S. P. asks: How much water will a boiler of given horse-power evaporate per hour — say 40 horse-power? A.—It is well known that the horse-power of a boiler is a very indeterminate quantity because the power ultimately depends upon the engine employed, and there is such a difference in engine performance. What is known as the "Centennial" standard for the horse-power of boilers, also adopted by the American Society of Mechanical Engineers, is "the evaporation of 30 pounds of water per hour from a feed-water temperature of 100 degrees Fahr., into steam at 70 pounds, gage pressure." This probably corresponds pretty well with the water consumption of the average steam engine, although some engines are said to consume as low as 12 pounds of water per horse-power per hour, while some steam pumps are said to consume 250 pounds.

(29) G. H. C., Mt. Carmel, Ill., writes: Please state in your column of Questions and Answers what is a proper process of tempering pipe cutters, dies, knurling wheels, etc., so that they will not crumble off or burst. Is there not a preferred process other than dipping in water and then drawing? A.—This question seems to call for a complete and comprehensive treatise upon hardening and tempering, which this column, of course, cannot undertake to supply. Much information upon this subject has appeared in our former issues, and much more is likely to continue to follow it. We do not know any better way to harden steel than by suddenly cooling it, and generally in clear water. Of course, there are various methods of heating, modes of cooling, and also various ways of reheating for drawing the temper. The crumbling spoken of may be on account of the steel being originally bad, or on account of overheating; and the bursting may be on account of shrinkage strains, which even the most expert do not always succeed in avoiding. Only long experience can bring success in tempering steel.

(30) W. A. S., Providence, R. I., asks: What will be the diameter of a cylinder 18 inches long to hold enough compressed air, at 60 pounds gage pressure, to run a nozzle with $\frac{1}{64}$-inch outlet 20 minutes and still have a pressure of 5 pounds? A.—We assume that a pressure reducer is employed, and that the nozzle will constantly discharge the air under a pressure of 5 pounds, so that a uniform flow of air will be maintained. Air at 60 pounds gage pressure, or 75 pounds absolute, or 5 atmospheres, will occupy one-fifth of the space occupied by the same air at a pressure of 1 atmosphere, free air, so that the capacity of the receiver will be one-fifth of that required for the total volume of free air employed. By experiment it has been ascertained that a $\frac{1}{64}$-inch nozzle wit a pressure of 5 pounds, will discharge .07 cubic feet of free air per minute; and for the 20 minutes, therefore, the discharge will be $.07 \times 20 = 1.4$ cubic feet, or, say, 1.5 cubic feet of free air. When the pressure in the cylinder has fallen from 60 pounds to 5 pounds, it will still contain $\frac{20}{75}$, or $\frac{4}{15}$, of the original charge; and as the amount used has been $\frac{55}{75}$, or $\frac{11}{15}$, of the original charge, and as that, as previously ascertained, is 1.5 cubic feet of free air, we add $1.5 \times \frac{4}{11} = .54$ to this, making together 2.04 cubic feet, or, say, 2 cubic feet; and as one-fifth of this volume, .4 cubic feet, or 691 cubic inches, is the capacity of the cylinder required, with 18 inches for the length of it, we assume x for the diameter, and its value is readily ascertained as follows:

$$x^2 \times .7854 \times 18 = 691,$$

and $x = 7$ inches, the diameter required, very nearly. It may be well to remember that $\frac{1}{64}$ inch is a very small hole, and, in practice, a slight variation in the size of it might apparently belie these figures.

(31) F. C. S., Delaware, O., writes: In your issue of December 19th, you reply to my inquiry of how great a pitch can be used for ⅜, ½ and ⅝-inch steel boiler plates, in which I also stated that 4, 4½ or 5-inch pitch had been used for ½-inch plates. In your answer, a 4-inch pitch is condemned for ½-inch plates, and for some reason you refer to iron sheets which are now hardly used at all. Some six or seven years ago, the "Locomotive," published by the Hartford Steam Boiler Inspection & Insurance Co., advocated, I think, 4½ to 5-inch pitch for ½-inch plates, and showed, I believe, that the strongest joint, some 80 or 85 per cent. of the solid sheet, could be obtained by increasing the pitch to such figures, saying also in effect that the pitch should be as great as was possible to keep tight. I think the rivets were an inch or 1¼ inches diameter. I do not understand why you consider only iron sheets, and why you keep down to such small rivets. I think this subject will pay you to look into, as your answer does not represent modern practice. A.—You have evidently read our answer hastily, and overlooked what we had to say in regard to steel plates. You are also mistaken in your statement that iron plates are now hardly used at all, for they are still used to quite an extent. We have looked thoroughly

into the subject of riveted joints, and still condemn a 4-inch pitch for a ½-inch plate. In our issues of October 2d and 30th, 1890, we have shown the method of computing the strength of riveted joints, and have given tables of pitch of rivets for different thicknesses of iron and steel plates, and these agree with modern practice. In the "Locomotive," the publication you refer to, page 97, July, 1891, you will find rules given for the proportions and strength of riveted joints, and according to these rules you cannot get 4-inch pitch of rivets for ½-inch steel plates. In this paper it is stated that, "In calculating the strength of a single-riveted joint, we must know: First—what the tensile strength of the iron or steel plate is, from tensile tests; second—the diameter and pitch of rivets; and third—the resistance to shearing per square inch of the material of which the rivets are made." Further on it is stated that, "In deciding upon these elements of the problem, we must so adjust the size and pitch of rivets as to make the shearing resistance of the rivets as near the strength of net section of plate as possible." We do not find a statement that the pitch of rivets should be as large as can be made for tightness. The pitch of rivets is also discussed in the "Treatise on Steam Boilers," by Robert Wilson, a recognized authority, and the conclusion which he gives practically agrees with ours. You have evidently not looked into this subject much, otherwise you would not advocate a 4 or 5-inch pitch of rivets for ¼-inch plates, with seams either double or single-riveted.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear wheels gear cutting. Grant; see page 32.

Power Hammers. Beaudry & Co., Boston.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patents, write Walter Donaldson & Co., Wash. D.C.

Model making and electrical experimental work. F. W. Gardam & Co., 58 Ann st., N. Y.

Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Brazing Wire and Bicycle Supplies; repairers and manufacturers; see Haines' ad. Ref. index.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill, 913 Tilden street, Saginaw, Mich.

A book for superintendents. "Hawkins' Calculations" (descriptive), $2.50 postpaid. Catalog free. Theo. Audel & Co., 91 Liberty Street, N. Y.

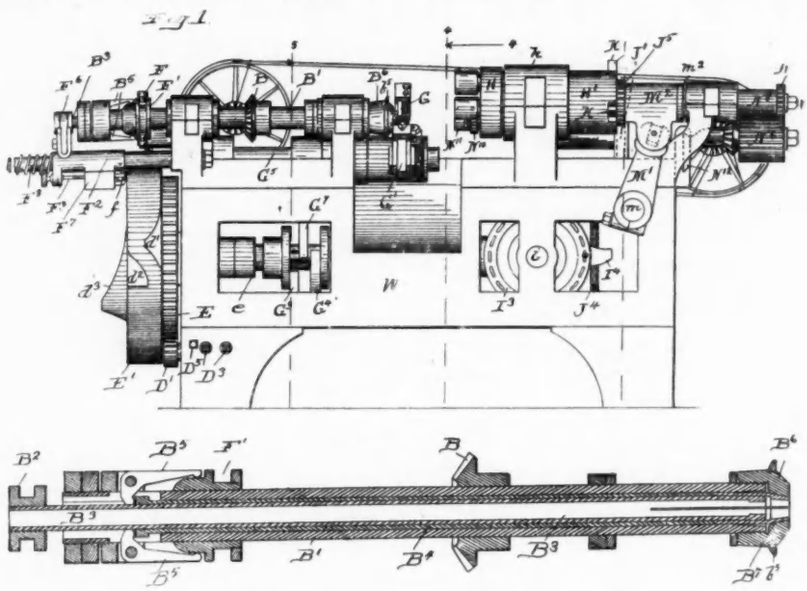
Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

Thin emery wheels, for cutting slots, etc., a specialty. The Tanite Co., Stroudsburg, Pa.; 161 Washington street, New York; 139 East Pearl street, Cincinnati, O.

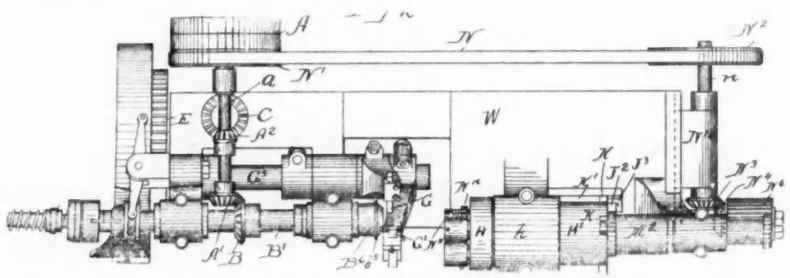
Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

Some Recent Inventions in Metal-Working Machines and Tools.

Figs. 1, 2, 3 and 4 illustrate a screw machine recently patented to Mr. C. E. Roberts, of Oak Park, Ill., a construction



having some points in common with one by the same inventor recently described in these columns. The figures represent, respectively, the front elevation, plan, a



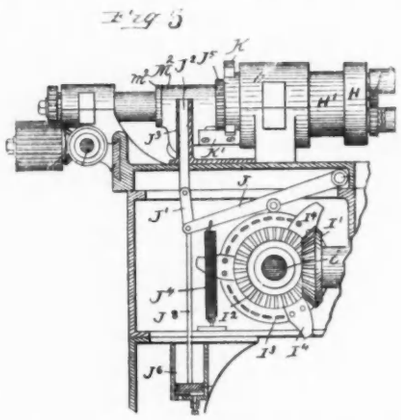
partial longitudinal section and a cross-section on line 4, Fig. 1.

As will be seen from Fig. 2, the power shaft is at right angles to the length of the bed, an arrangement permitting compact grouping of the machines, and the driving of a large number from the line shaft without the interposition of counter-shafting. The stock spindle and cam-shaft driving worm are driven direct from shaft *a*, and the tool head indirectly through belt *N*.

This tool-driving shaft, together with the gears N^3, N^4, is carried in a laterally adjustable head N^{12}, to permit the use of change gears for regulating the speed of the tool. One of these latter gears is long, to allow longitudinal motion of the tool head; which motion is effected by the lever M^1 (Fig. 1) on the rockshaft *m*, the latter being actuated by a cam on the rear end of shaft *i*, as will be readily understood.

It will be noted that the sleeve H^1 carrying the tool head is exceptionally large and very firmly mounted, to give steadiness to the tools even when extended to its utmost position. The manner of driving the various tool holders, and of registering each tool with the stock by the guide K^1 and bifurcated arms *K*, is similar to that in the machine before described, and will be understood therefrom.

The stock-driving and feeding spindle at the opposite end of the machine is also similar in construction and operation, except that it is not double, as shown in the previous construction. The manner of

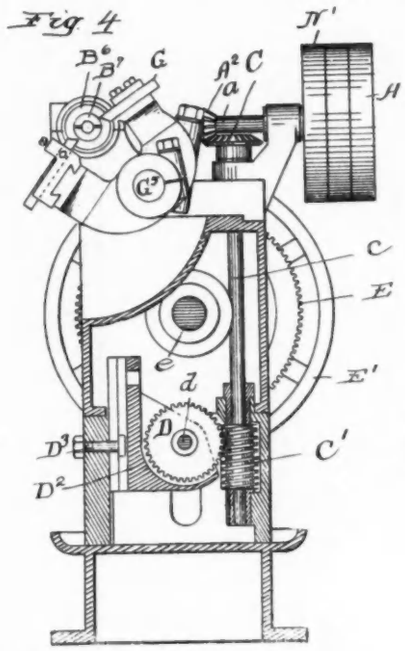


adjusting the rod feed is shown at F^7, F^8, *f* (Fig. 1). F^7 being dovetailed on F^2, is longitudinally adjusted by the milled-head screw, so that the whole or only a

portion of the face of cam d^3 will act thereon, giving to the stock, when the chuck is opened by cams d^1, d^2, a longer or shorter throw. A flange b^5 on the chuck end of the stock spindle deflects the oil and chips from the main bearings.

The cam movements for operating the

Fig. 4



cutting-off tools, rotating the tool head, etc., are arranged as follows: The upright shaft e (Fig. 4) carries a long worm for driving worm wheel D in any position it may occupy. This wheel in block D^2 is vertically adjustable, to permit the use of

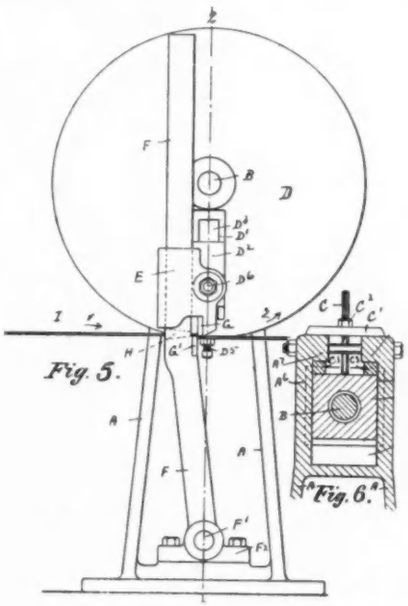


Fig. 5. Fig. 6.

change gears at D^1 (Fig. 1), on the same shaft, to secure different feeding-cam speeds.

On shaft G^5 (Figs. 1 and 4) an arm, oscillated by cams on shaft e, actuates the cutting-off tools; while on shaft i (Fig. 3), driven from e, is the tool-head rotating mechanism, consisting of the rack J^3 and its operating link, lever cam and spring, as clearly shown by the figure. The cam is capable of a large range of adjustment of the movable cam pieces J^4, giving any desired rotation or oscillation of the tool head. A dash pot J^6 cushions the spring return of the rack and prevents shock and noise.

Figs. 5 and 6 show a shear, the invention of Mr. V. E. Edwards, of Worcester, Mass., for cutting moving rods to length as they leave the rolling mill.

The upper shear is carried on a block which moves on the swing lever F, and is driven by the radially adjustable pin D^a, in disk D. The slider D^2, carrying this pin, is adjusted in the radial slot by suitable backing blocks, and locked in place by a set screw.

The rod passes through a coned aperture H, in the swing lever, just above the lower blade G^1. It will be readily seen that the length of rod will be equal to the circumference of the crank-pin circle; and, inasmuch as the rod must preserve always about the same height, provision is made for lowering the main shaft B when the crank pin is moved nearer the center. This means will be understood from Fig. 6, a cross-section of the shaft bearing in rear of disk D. The rods C effect the necessary adjustment, drawing the bearing against spacing pieces e^3, e^4; transverse bolts further acting to clamp the bearing.

The Expression of Arithmetical Rules by Algebraic Formulas.

In Three Parts—Part I.

It is too often assumed by practical men that if they do not understand algebra, rules expressed in algebraic signs are of no use to them, and articles containing such expressions must be considered a sealed book.

This is an error which it is the purpose of this and the following articles to dispel. The fact is, that when a rule has been worked out and is presented in its final algebraic form, the work of the algebraist is done, and the resulting formula is simply an arithmetical rule expressed in abbreviated or sign language. In this language each arithmetical operation of addition, multiplication, etc., is represented by a sign of its own; a letter is made to stand in place of the descriptive name of each quantity which enters the problem; and a formula is simply a string of such letters connected by the signs which show the additions, multiplications, etc., which are to be performed in order to obtain what is wanted. In applying such a formula to a practical example, it is only necessary to replace the various letters by the numbers for which they stand, and then perform the operations called for by the signs.

Mr. Mason's first article stated that he was "a stranger to mathematics" and that his notes "would not include that stumbling block." Some of the readers of this paper seem to think he has forgotten his promise, but he has not. The simple formulas he has used cannot fairly be called mathematics, and in point of fact there is nothing which he has written is not within the easy comprehension of anyone who will read this and the following articles attentively. Some of his apparently more complicated expressions will be used as illustrations in these articles, thereby accomplishing the double purpose of explaining the use of formulas, and, in particular, the meaning of his.

The most natural question for the reader to ask at this point is: "If, then, algebraic formulas are only arithmetical rules expressed in another language, of what advantage are they? Why should not the language of arithmetic, which all understand, be used, instead of inventing another in which to say the same thing?"

This is a fair question, and the reply to it is a statement of the advantages of formulas over rules, as follows:

1st. The entire expression comes at one glance before the eye, so that the relations of the various quantities and the operations to be performed are taken in at once, instead of piecemeal, as is the case with a long arithmetical rule. In other words, the formula is clearer than the rule, and not only clearer, but very much clearer.

2d. The formulas are transformed with the greatest readiness—that is, for instance, a formula giving the horse-power of a given belt at a given speed may be transformed to give the width of belt necessary to carry a given horse-power.

3d. The formulas are written, handled and derived with an immense saving in the labor of penmanship, it being necessary to write a single letter only in place of a long descriptive name for which it stands, and signs such as $\times$ in place of its meaning, multiplied by, or $+$ in place of added to.

Algebraic language, then, consists of two parts: First, a set of signs to represent all the operations of arithmetic; and, secondly, letters, each of which stands for one of the quantities or data which enter the problem, for which the formula expresses the rule.

The signs which indicate the principal arithmetical operations are as follows:

$+$, which indicates that the quantities represented by the letters between which it is placed are to be added together. Thus, $a + b$, which is read a plus b, indicates that the quantities represented by a and b are to be added together. The reader will ask, "How can a and b be added together, and what sort of a thing will the result be?" The answer is that a and b are not and cannot be added together, any more than a house and a railroad bridge can be added; but if a stands for five miles

and b for seven miles, then those quantities can be added, and the formula simply shows that they are to be added.

—, which indicates that the quantity represented by the letter after it is to be subtracted from the one represented by the letter before it. Thus, $a - b$, which is read a minus b, indicates that the quantity represented by b is to be subtracted from the one represented by a. The remarks about the addition of a and b apply here also, as well as to multiplication and division, which follow.

$\times$, which indicates that the quantites represented by the letters between which it stands are to be multiplied together. Thus, $a \times b$, which is read a multiplied by b, indicates that the quantities represented by a and b are to be multiplied together. The sign of multiplication is often omitted between letters; thus, $a\ b$ also indicates that the quantities represented by a and b are to be multiplied together. This expression may be read as it stands, $a\ b$, or it may be read a multiplied by b, the meaning being the same. Another sign for multiplication sometimes, though not often used, is a dot. Thus, $a \cdot b$ has the same meaning as $a \times b$ and $a\ b$. This omission of the sign for multiplication is practiced between letters only, since, obviously, it would lead to errors if practiced between figures: 7×9 could not be written 79, as it becomes at once seventy-nine, not seven multiplied by nine. Where letters follow figures the sign is usually omitted; thus, $8a$ is the same as $8 \times a$, and $25\ a\ b$ is the same as $25 \times a \times b$. A number written before letters in this way is called a coefficient. Where numbers follow letters, the sign is usually though not necessarily used, as the omission of the sign could not cause confusion.

$\div$, which indicates that the quantity represented by the letter before it is to be divided by the quantity represented by the letter following it. Division is also (and very often) indicated by writing the quantities in the form of a fraction. Thus, for a divided by b we may write $a \div b$ or $\frac{a}{b}$. The fractional form is sometimes read a over b.

The above signs express the four cardinal operations of arithmetic, and by their use any rule which contains only those operations may be expressed. Take, for example, the following rule: To find the horse-power which a single thickness of belt will carry, multiply together the diameter of the pulley in feet, the width of the belt in inches, the number of revolutions per minute, and the number 3.1416, and divide the result by 600. By introducing the above signs, this rule may be written as follows:

The horse-power of a single thickness of belt is equal to

$$\frac{\left\{\begin{matrix}\text{the diameter of the}\\ \text{pulley in}\\ \text{feet}\end{matrix}\right\} \times \left\{\begin{matrix}\text{the width}\\ \text{of the belt}\\ \text{in inches}\end{matrix}\right\} \times \left\{\begin{matrix}\text{the revolutions}\\ \text{per minute}\end{matrix}\right\} \times 3.1416}{600}$$

In the above occur four long phrases. Now, let us agree that

x shall stand for the horse-power of the belt;

a shall stand for the diameter of the pulley in feet;

b shall stand for the width of the belt in inches;

c shall stand for the revolutions per minute.

Put these letters in place of the things for which they stand and we have:

$$x \text{ is equal to } \frac{a \times b \times c \times 3.1416}{600}$$

Here we still have the phrase "is equal to"; and as this occurs in every formula, a sign for it would save much writing. The sign is $=$, which means and is read "equals" or "is equal to." Putting this in its place, we have:

$$x = \frac{a \times b \times c \times 3.1416}{600}$$

a full-fledged algebraic formula, but certainly nothing to be frightened at. All rules when expressed in algebra are put in this form—the thing to be found, by itself, upon one side of the equation; and the things given, from which to get the thing to be found, by themselves, upon the other side, and connected by the signs which show what must be done with them to give the thing wanted.

Such an expression is called a "formula" or an "equation." The "unknown quantity" or thing to be found is usually, though not always, expressed by one of the last letters of the alphabet—x, y or z; while the "known quantities"—that is, the things given, the data—are expressed by the other letters.

In the belt formula, x, standing for the horse-power of the belt, which is the thing which we are trying to find, is the unknown quantity; $a\ b$ and c, standing for the data given, are the known quantities. The unknown quantity is usually though not necessarily placed upon the left side of the sign of equality, and the known quantities upon the right side.

The numerical quantities 600 and 3.1416 are also, of course, known quantities, but the expression "known quantities" is applied only to the letters which represent the data which are given in any practical problem to which the formula applies. Numerical quantities which do not change with different practical problems, are called "constants," or when written before the letters "coefficients," as has been explained.

If the reader will compare this one-line formula with the six-line rule which it represents, he will see the force of the first and third advantages of algebra, as outlined at the start. These advantages, however, are still more pronounced with more complicated formulas—rules which it would be hardly possible to write so as to be understandable, becoming as plain as daylight when expressed in this shorthand arithmetic.

The different signs for multiplication and division enable this formula to be expressed in several ways. Thus we may write

$$x = \frac{a\ b\ c \times 3.1416}{600} \text{ or}$$

$$x = a\ b\ c \times 3.1416 \div 600 \text{ or}$$

$$x = a\ b\ c \times \frac{3.1416}{600} \text{ or}$$

$$x = \frac{3.1416}{600}\ a\ b\ c \text{ or}$$

$$x = 3.1416\ \frac{a\ b\ c}{600}$$

The last three forms grow out of the fact that, first, it is a matter of indifference in what order numbers be multiplied together; thus, 3 x 8 x 16 gives the same result as 3 x 16 x 8 or 16 x 3 x 8; and, secondly, that in a case like the above, the result is the same whether all the multiplications be performed first and the product be then divided by the divisor, or whether the division be first performed on one of the numbers and the result be then multiplied by the remaining numbers. Thus, $\frac{8 \times 7 \times 12}{4}$ gives the same result as $\frac{8}{4} \times 7 \times 12$ or $8 \times 7 \times \frac{12}{4}$ or $8 \times \frac{7}{4} \times 12$.

The above illustrations will serve to show the meaning of formulas. Let us next consider how they are used in solving a practical problem:

An 8-inch single belt runs over a 30-inch pulley, running at 150 revolutions per minute. What horse-power is it capable of carrying? In this problem

$a = 2\frac{1}{2}$ (as we agreed that a should represent the diameter in feet.)
$b = 8$
$c = 150$

Substitute these values of the letters for the letters in the first form of the formula, and we have:

$$x = \frac{2\frac{1}{2} \times 8 \times 150 \times 3.1416}{600}$$

Perform the multiplications and the division here indicated, and the result is $x = 15.7$, nearly—that is, the belt is capable of carrying nearly 16 horse-power.

This is the manner in which formulas are applied to actual examples. It is not at all necessary for the reader to understand the intricacies of the science of algebra, in order to use the formulas intelligently and understandingly. A clear understanding of the signs, and of the fact that the letters are simply abbreviated symbols for long descriptive names, is all that is required for this purpose. The following articles will take up the additional signs, and also the methods of transforming equations. Meanwhile, we cannot too strongly urge that the reader should clearly comprehend what has been given before going further.

C. K. JACKSON.

At the Hotel Normandie, Washington, where two dynamos are driven by separate engines, the dynamos are so placed that by slewing them around, and using special belts kept in readiness, either or both dynamos may be driven by either engine as the exigencies may demand.

COMMERCIAL REVIEW.

NEW YORK, SATURDAY EVENING, FEB. 1.

The Machinery Trade.

The past week has witnessed the featureless closing of a month in the machine tool trade which has, at least in this market, left sadly unfulfilled the hopes of business previously entertained. Some of the factories are kept employed in certain, or all, departments, but this must be attributed partly to still unexecuted contracts remaining over from the boom in bicycle manufacturing tools, which has spent much of its force. The present demand for machinery comes more from established mills than for the fitting up of new ones, and the lack of confidence which has of late been restraining the investment of new capital still reigns.

The question as to how January, 1896, compares with January, 1895, meets with a variety of replies, but it is evident from the weight of authority that large tools are in no better selling than they were a year ago, and in lighter tools, for which there is more call than for the heavy ones, the improvement, if any exists, is trifling. To be sure there are several well-known manufacturers whose New York agencies are in new hands or unusually aggressive or are having a run of good fortune, and these report such greatly increasing business that, perhaps, the total volume of trade may be a little greater than in January, 1896. But when we hear from the standpoint of a firm doing a large and well established business, the unhesitating statement that business falls below that of a year ago, we are bound to admit the normal lines of trade are at present very unhealthy in tone.

The outlook, though not brilliant, is somewhat hopeful. February and the two months following should, under ordinary conditions, see a large amount of business and it ought not to be long before it reaches at least its December footing. The most popular line of tools is still said to be screw machines, and prices are becoming fossilized.

As to wood working machinery, we learn from the H. B. Smith Machine Company, that trade in New York and vicinity is in a deplorable state and apparently without a ray of hope for the future. At the first part of the month, inquiries were quite numerous, but they have not resulted in placing of contracts. The lack of confidence in business at large seems to be the cause of a withholding of capital from investment in wood working enterprises, as well as in a great many other things.

This cloud may be blown away by a breeze of returning public assurance, but there are others by which the wood working business is darkened and which are likely to remain. The first is, that stone and iron and brick and mortar have so superseded wood in urban construction, that some buildings are erected almost without being entered by a carpenter, and wood working is therefore at a discount. Secondly, and as a result of this, second hand tools flood the market, crowding out new ones even where they might otherwise be required. A third obstacle is found in strikes and labor disturbances. That the outlook is much better in other parts of the country cannot be doubted, but in New York the prospect is pronounced more gloomy than a year ago.

A bright spot on a darkened background is power transmitting machinery, in which A. & F. Brown report that there is more business than in December, and more than in January, 1895. They are busy in ministering to a trade which is quite evenly distributed though the demand from cotton mills constitutes something of a feature. Prices were well hammered down in 1895, and they remain hammered.

Iron and Other Metals.

The iron market manifests a slightly improving tendency, but one that is far from sensational in character. Pig iron shows a fair amount of activity and the volume of business seems to be gradually increasing. There exists a fear that the iron market will suffer from a lack of railroad buying; owing to the low prices of produce. It is said that western farmers are cribbing their corn and will not ship grain and hogs at present figures; which would mean a loss of freight to the granger roads and make them reluctant to lay in supplies during the spring and summer. But these views are not shared by all, and it is said, on the other hand, that this cribbing of corn has not become general, and that the present earnings of northwestern roads are such as to render the situation encouraging.

Machinery and tool steel are rather quiet, and especially so during the past week, because people do not buy freely on the last and first day or two of each month. There is a stiffening in the price of machinery steel, but without quotable change. Buyers are disinclined to contract far ahead at present prices.

Copper continues its upward movement. Speculation has been rife in Europe, and this has stimulated American buyers. There are prospects of a consumption as heavy as that of last year, but the production of American mines will be sufficient to meet a large demand.

The lead market has shown fair activity with the price ruling steady. More business is imminent.

Pig tin has made a notable gain in price, as a result of European quotations that seem to have been strengthened by the interest aroused in copper.

Spelter has been quiet and featureless with the prices practically unchanged.

Pittsburg Report for January.

Throughout this district the course of the general iron and steel market has been slightly upward. Some lines show more improvement than others, both in demand and prices. Reports announcing the restriction of iron ore production during the coming season, and that the coke prices are to be maintained, have had considerable to do with improving the market. Raw material is gradually advancing in price each week, and what is now wanted, is for the same thing to occur in the finished lines, and all indications point this way. Mill irons are in pretty fair demand and are growing stiffer each week, but there seems to be a lull in foundry irons. Several of the medium sized foundries in this locality are making only two small heats per week, where one large one per day was formerly the case, while some others are seriously considering the question of shutting down to await a change.

The general condition of the foundry trade is moderately fair, generally speaking, in fact, it is fully 50 per cent. better than for the same period last year. Wages are nearly as high as they were in 1890, there being only two per cent. difference, while prices for finished goods are almost 15 per cent. less than they were during the year.

In the machine trade, business is gradually assuming its old form, and the reports from the different large machinists in this city show that there are a moderately fair amount of orders being placed and that the prospects for more are exceedingly bright. One bad feature of the market which is hard to overcome is the continued demand for second-hand machinery. Inquiries are numerous for such a class of goods. A gradual improvement in volume and tone for all kinds of machinery can be expected.

"Mill supplies are in heavy demand," was the statement made by Mr. Wm. Rodgers, of the Pittsburg Gauge Company, a few days ago to the writer. The company has its force of men employed day and night, and has orders on its books calling for shafting, belting, steam specialties, etc., that will keep them busy for some months to come. Prices in this line are about 10 per cent. better than last year, and are about equal to those ruling in 1892. Numerous concerns have allowed their plants to run along without any repairs as far as possible, and these, together with a number of new manufacturing places, are being fitted up, making the demand quite brisk.

In the engine and boiler business, several large orders are on the verge of being closed, notably for engines, boilers, pumps, etc., for the new plant to be erected at Beaver Falls by the Keystone Axle Company, of Baltimore.

A contract was secured by a representative of a large Eastern concern for the engines, boilers, pumps, etc., for the Washington (Pa.) Tin Plate Company's plant. Numerous other contract work

is under way, and taken altogether, this branch of trade is pretty lively.

For fans, blowers, drill presses, lathes, planers, etc., there is a constant demand and business is rapidly nearing its old condition. The Sheriff Machinery Company reports the market as 100 per cent. better than a year ago, and that the prospects are very encouraging in nearly all lines. This concern has been recently awarded several large sized contracts for equipping manufacturing plants, in different portions of this State and West Virginia. As regards feed water heaters, purifiers, injectors, water columns, etc., there is an active demand. Competition is very keen in this line, and prices, as a rule, are being shaded at every opportunity. A contract for heaters was awarded a Pittsburgh concern a few days ago, on which very little profit, if any, will be made.

Electricity is finding its way into every manufacturing plant, and also numerous large stores for lighting purposes. It is understood that the National Tube Works Company, of McKeesport, is connecting a dynamo to the machinery of No. 8 welding furnace, and that the results so far attained have been highly satisfactory. Three new electric lighting plants have been installed within the past few weeks by Lea & Carroll, who represent the McEwen interests in this district. Other concerns are also actively engaged and are kept on the alert continually, as many new electric light plants are contemplated by suburban towns. Several nice sized contracts for electric hoisting machinery are soon to be awarded and agents representing large concerns are straining every nerve for the coveted work.

In the hardware business, the prospect for a good spring business continues very fair, and it is the general belief that prices will advance all around. It is fully expected that the demand for bicycles will be much larger than it was last year. The prices of nails are still strong, the rates being $2.25 and $2.35 for carload lots.

Locally, the future is growing brighter day by day, and this more cheerful aspect extends over the entire Western markets. Were the financial conditions better the outlook would be much more promising.

QUOTATIONS.

NEW YORK, Monday, February 3d.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$13 00 @ $13 50
No. 2 foundry, Northern	12 00 @ 12 50
No. 2 plain, Northern	11 25 @ 11 75
Gray Forge	11 75 @ 12 00
No. 1 foundry, Southern	12 50 @ 12 75
No. 2 foundry, Southern	12 00 @ 12 50
No. 3 foundry, Southern	11 75 @ 12 00
No. 1 soft, Southern	12 25 @ 12 50
No. 2 soft, Southern	11 75 @ 12 00
Foundry forge, Southern	11 25 @ 11 75

Bar Iron—Mill price, on dock: common, 1.25 @ 1.30c.; refined, 1.30 @ 1.50c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c. extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—About 1.55c. in carloads, mill price; from store, 1.85c. Special brands upward.

Cold Rolled Steel Shafting—Base, 2½c. in carloads; 2¾c. in smaller quantities; 3c. from store.

Copper, Carload Lots—Lake Superior ingot, 10⅛ @ 10½c.; electrolytic, 9⅞c.; casting copper, 9⅛ @ 9¾c.

Pig Tin—For 10-ton lots, 13.55c. cash.

Pig Lead—In carloads, 3.12½ @ 3.15c.

Spelter—Western brands, 4.05c. in car loads. New York delivery.

Antimony—In wholesale lots, Cookson's, 7¾ @ 7⅞c.; Hallett's, 6⅞ @ 7c.; Japanese, 6¾ @ 6⅞c.

Lard Oil—Prime city, present make, 52 @ 54c. in large quantities.

NEW CATALOGS.

There are three sizes of Standard Catalogs, 9"X12", 6" X 9" and 4½" X 6". We recommend the 6" X 9" size for machinery catalogs. When they must be larger or smaller, one or the other standard sizes should be adopted if possible.

The Scientific Machinist Co., Cleveland, O., issue a descriptive catalog of the Institute for Home Study. This catalog sets forth in considerable detail the courses of study followed in this institute, and there are a number of engravings of apparatus used, and full information is given regarding the school. It is sent to those interested on application, and is 6¾ x 10 inches.

MANUFACTURES.

A new mill is being added to the J. H. Sternberg's Bolt and Nut Works, at Reading, Pa. This new addition will be 80 x 200 feet, and will contain two trains of rolls, each 18 feet long.

The Altoona shops of the P. R. R. were given orders on January 28th for six Class U and twelve Class M engines. The Juniata shops were also given orders for eight Class L and twelve Mogul engines.

Phœnixville Bridge Co., Phœnixville, Pa., has secured the contract for the material of the framework of the new United States cruisers to be built at Newport News. It is a large contract, and will give employment to many men for several months.

A contract has been closed with M. A. Carter & Co., of St. Louis, Mo., for the construction of a railway bridge across the Mississippi, from Davenport to Rock Island. It will be commenced at once, and will be completed about September 1st, 1897.

At Erie, Pa., preparations are being made for the erection of a large plant for the manufacture of gas engines. Mr. Curtze is interested, as is also Mr. Wm. Hardwick, of the Erie Engine Works. It means increased trade for many of the manufacturers of that place, especially the Globe Iron Works and the Keystone Electric Works, and will give employment to many men.

The Clayton Air Compressor Works, Havemeyer Building, New York, report recent sale of a large Duplex Steam-Actuated Air Compressor, to the Pennsylvania Railroad Co., for the various applications of this power in their Altoona shops. This company also has orders for several large compressors from other railroad companies, for their shop uses of compressed air, and are also doing a large business in smaller compressors, for testing and inflating hose and bicycle tires and for supplying crude oil burners.

In San Francisco, Cal., the three distinct businesses heretofore conducted under the several names of Edward A. Rix, Wm. A. Hewitt and The Rock Drill and Air Compressor Machine Works, have been consolidated and incorporated under the name of the Rix Compressed Air Machinery Co., with Edward A. Rix, as president and manager, the offices of the company being at 11 and 13 First street, San Francisco. The corporation will conduct the business heretofore carried on by all three concerns, making a specialty of compressed-air machinery. Their store is to be provided with power, and customers will be able to see the various machinery in operation.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our subscription list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Position as brass foundry foreman by a man of exp. Address J. B., care AM. MACHINIST.

Mech. draftsman wants pos., exp. in h. grade eng., water tubes boilers, etc. Box 31, AM. MACHINIST.

Wanted—A dftsman of exper. on large steam eng. work. Amer. Wheelock Eng. Co., Worcester, Mass.

Wanted—Position as supt. or f'man of mch. shop; good Phila refs. Address Roberts, care AM. MACH.

Wanted—Position by A1 gauge and tool maker. Handled men. Address H., AMERICAN MACHINIST.

Wanted—First-class machinists (close workmen). At the works of the Vermont Farm Machine Co., Bellows Falls, Vt.

Wanted—Experienced man to install high-speed engines; also draftsman competent to take charge. Address BOX 33, AMERICAN MACHINIST.

Wanted—Fifty first-class machinists, vise-hands, lathe and planer hands. Apply to the Lodge & Davis Machine Tool Co., Cincinnati, O.

Wanted—By foreman boiler maker, sit. in marine or loco. shop where first-class work is required. Good references. Box 373, Victor, New York

Wanted—Situation by experienced machinist and tool maker, as foreman of machine shop or bicycle works. Address BOX 26, AMERICAN MACHINIST.

Wanted—A change of foremanship by a first-class man. At present a foreman in a large engine works. Address J. H. H., care AM. MACHINIST.

Wanted—A good machine tool man as the contractor for the output of entire plant. A good opening for the right man. Box 15, AM. MACH.

Brass foundry fireman wants situation; understands all branches of the business; 15 years a fireman; A 1 reference. Address Brass, AM. MACH.

Wanted—Electrical engineer and designer of sp'l firing devices for gas and gasoline engines is open for engagement. Address Electric, care AM. MACH.

Wanted—First-class op'rat'rs on automatic screw machines, Hartford or Cleveland. Write, stating age, exp. and salary expected. Box 34, AM. MACH.

Wanted—Mech. draughtsman desires position. Techn. grad. and 2 yrs. exp. in drwg. room on st'm pumps and gen. m'chin's. Address K. O., AM. MACH.

Comp. draftsman wants pos., exp'd in H. S. eng., four valve eng., water tube boilers, etc.; some experience in designing. Box 32, AMER. MACHINIST.

A practical machinist 40 yrs. old, 12 yrs. in charge of men; making piece-work prices and estimates, wants position. R. A., care AMERICAN MACHINIST.

Wanted—An energetic and experienced man to take charge of 100 screw machines on first-class work. State age, experience and salary expected. Box 29, AMERICAN MACHINIST.

Young man, tech. edu., desires change of position in erecting steam engine or pumping machinery. Exper. in both shop and road work. Road work preferred. Address N., AMERICAN MACHINIST.

Wanted—Man of exp. to take charge of tool room in brass-wkg estab. Must be thoroughly familiar with mod. tools and methods; a hustler. No experimenter need apply. Box 30, AMER. MACHINIST.

Situation by a first-class gear cutter and machinist—Have had four years' experience in gear cutting. Would like to take charge of a gear-cutting department. Box 27, AMERICAN MACHINIST.

Position of trust by man with 15 years' experience in machine shops, drafting rooms and foundries of leading firms; understands mixing iron; south of Pennsylvania preferred. Address C., care AMERICAN MACHINIST.

Mechanical engineer, American, age 29, tech. grad., experienced constructor on ice mach'y, Corliss, steam and gas engines, wants position as engineer or constructor; highest-class references as to ability and character. Box 8, AM. MACH.

Mech. Engineer, 20 yrs. prac. in bld'ng & erecting mach., bld'ngs, etc., for rolling mill steel plant and structural iron work, wants position; exp. covers steam, electric, pneumatic and hydraulic installations; memb. A.S.M.E. Address Box 28, AM. MACH.

Wanted—A young, energetic man as foreman of a mach. shop employing from 15 to 20 machinists, shop located in Western Penn. Give reference, age, nationality & knowledge of mechanical drawing & state where last was acquired; also state wages wanted. Address B., care AM. MACH. PUB. CO.

Manufacturer wishing reliable, energetic man of business experience for office, shop or road, who is a fair machinist, draftsman, and engineer of large plants, familiar with indicators; competent to take full charge of books, office and correspondence, sell productions, take measurements, etc. Please address E. G., care AMERICAN MACHINIST.

MISCELLANEOUS WANTS.

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York,Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden st., Saginaw, Mich.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses,engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Threads and Gears, by G. W. Dixon, Spring Lake, Mich. Easy rules to find gears to cut any thread possible to be cut in lathe. No algebra. Sent to any address on receipt of 25 cents.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E, Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offered to inventors.

FOR SALE.

The Westinghouse Machine Company is about moving into its new plant, and offers at low prices certain machinery which will be replaced by more modern tools. Parties wishing to buy lathes, planers, boring mills, etc., may see tools in operation at Twenty-fifth and Liberty Streets, Pittsburgh, Pa.

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Grant Calculating Machine Co., Lexington, Mass.

Air Compressors.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sargeant Drill Co., New York.
Rand Drill Co., New York.

Auger Bits.
Adams, A. L., Bridgeport, Conn.

Balls, Steel.
Cleveland Machine Screw Co., Cleveland, O.

Belt Dressing.
Dixon Crucible Co., Joseph, Jersey City, N. J.

Bicycles.
Fenton Metallic Mfg. Co., Jamestown, N. Y.

Bicycle Supplies.
Haines Co., Wm. J., Philadelphia, Pa.

Bicycle Tools.
Ferracute Machine Co., Bridgeton, N. J.

Blowers.
American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Cooke & Co., New York.
Roots, P. H. & F. M., Connersville, Ind.
Sturtevant Co., B. F., Boston, Mass.

Boilers, Steam.
Orr & Sembower, Inc., Reading, Pa.
Sterling Co., The, Chicago, Ill.
Watts-Campbell Co., Newark, N. J.
Weston Engine Co., Painted Post, N. Y.

Bolt Cutters.
Acme Machinery Co., Cleveland, O.
Hill, Clarke & Co., Boston, Mass.
McCabe J. J., New York.
National Machinery Co., Tiffin, O.
Pratt & Whitney Co., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co, Chas. A., Detroit, Mich.
Wells Bros. & Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Books, Technical.
Baird & Co., Henry Carey, Philadelphia, Pa.
Grant, Geo. B., Lexington, Mass.
Open Court Publishing Co., Chicago, Ill.
Strelinger & Co., Chas. A., Detroit, Mich.
Wiley & Sons, John, New York.

Brazing Wire.
Haines Co., Wm. J., Philadelphia, Pa.

Bushings.
New Process Raw Hide Co., Syracuse, N. Y.

Calipers.
Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Athol, Mass.
Starrett, L. S., Athol, Mass.
Strelinger & Co., Chas. A., Detroit, Mich.
Wilkinson & Co., A. J., Boston, Mass.

Castings, Iron.
Builders Iron Foundry, Providence, R. I.
Burr & Houston Co., Brooklyn, N. Y.
Leland & Faulconer Mfg. Co, Detroit, Mich.
Shriver & Co., T., New York.

Castings, Steel.
Johnson Co., The, Johnstown, Pa.

Chucks, Drill.
Almond, T. R., Brooklyn, N. Y.
Cushman Chuck Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Morse Twist Drill & Machine Co, New Bedford, Mass.
Pratt Chuck Co., Clayville, N. Y.
Skinner Chuck Co., New Britain, Conn.
Trump Bros. Machine Co., Wilmington, Del.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Whiton Machine Co., D. E., New London, Conn.

Chucks, Lathe.
Cushman Chuck Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Chuck Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Pratt Chuck Co., Clayville, N. Y.
Skinner Chuck Co., New Britain, Conn.
Whiton Machine Co., D. E., New London, Conn

Clutches, Friction.
Brown, A. & F., New York.
Evans Friction Cone Co., Boston, Mass.
New Haven Mfg. Co., New Haven, Conn.

Computers.
Cox Computer Co., New York.

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Condensers.
Conover Mfg. Co., New York.
Guild & Garrison, Brooklyn, N. Y.
Worthington, Henry R., Brooklyn, N. Y.

Counting Machines.
Durant, W. N., Milwaukee, Wis.

Cranes.
Maris Bros., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Speidel & Roeper, Reading, Pa.

Cutting-Off Machines.
Armstrong Mfg. Co., The, Bridgeport, Conn.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Machine Co., So. Sudbury, Mass.

Damper Regulators.
Hine & Robertson Co., New York.

Dies, Screw Cutting.
Acme Machinery Co., Cleveland, O.
Besly & Co., Chas. H., Chicago, Ill.
Carpenter, J. M., Pawtucket, R. I.
Jones & Lamson Machine Co., Springfield, Vt.
Montgomery & Co., New York
Pratt & Whitney Co., Hartford, Conn.
Strelinger & Co., Chas. A., Detroit, Mich.
Taylor-Rice Engineering Co., Gloucester City, N. J
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drawing Instruments, Etc.
Alteneder & Sons, T., Philadelphia, Pa.
Keuffell & Esser Co., New York.

Drilling Machines.
Aurora Tool Works, Aurora, Ind.
Barnes Co., W. F. & John, Rockford, Ill.
Bickford Drill & Tool Co., Cincinnati, O.
Blaisdell & Co., P., Worcester, Mass.
Dallett & Co., Thos. H., Philadelphia, Pa.
Davis, W. P., Rochester, N. Y.
Davis & Egan Machine Tool Co., The, Cincinnati, O.
Dietz, Schumacher & Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
McCabe, J. J., New York.
Montgomery & Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles Tool Works Co., Hamilton, O.
Niles Tool Works Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Quint, A. D., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.
Timolat, J. G., New York.
Warner & Swasey, Cleveland, O.
Wilkinson & Co., A. J., Boston, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drill Rods.
Abbott, Wheelock & Co., Boston, Mass.

Drills, Twist.
Besly & Co., Chas. H., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Montgomery & Co., New York.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.

Drop Forgings.
Billings & Spencer Co., Hartford, Conn.
Wyman & Gordon, Worcester, Mass.

Dynamos.
Roth Bros. & Co., Chicago, Ill.

Elevators.
Albro-Clem Elevator Co., Philadelphia, Pa.

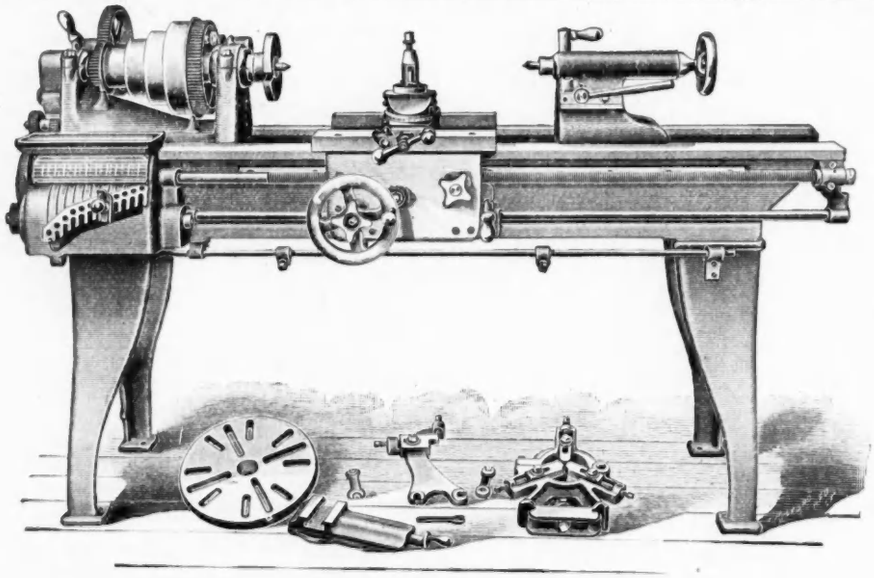
Emery Wheel Dressers.
Wrigley, T., Chicago, Ill.

Emery Wheels.
Besly & Co., Chas. H., Chicago, Ill.
Montgomery & Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Strelinger & Co., Chas. A., Detroit, Mich.
Sterling Emery Wheel Co., Tiffin, O.

Engines, Gas and Gasolene.
Otto Gas Engine Works, Philadelphia, Pa.

Engines, Steam.
Ames Iron Works, Oswego, N. Y.
Forbes & Co., W. D., Hoboken, N. J.
Frick Co., The, Waynesboro, Pa.
Keystone Engine and Machine Works, Philadelphia, Pa.
Orr & Sembower, Inc., Reading, Pa.
Watts-Campbell Co., Newark, N. J.
Weston Engine Co., Painted Post, N. Y.

Exhaust Oil Extractors.
Hine & Robertson Co., New York.



14 in. x 6 ft. Hendey-Norton Lathe with Improved Automatic Stop.

THIS Lathe COMBINES the LATEST and BEST Improvements. Automatic Stop. It is Simple, Durable, Indispensable. It will AUTOMATICALLY STOP the Carriage in EITHER direction. It is equally efficient whether FEEDING or THREAD-CUTTING. Running up to a shoulder, boring to BOTTOM of holes, or INTERNAL THREAD-CUTTING.

No danger of spoiling either tool or work. It is a safeguard against accidents, in either direction.

Feeds—It has all feeds in daily use with simple movement of lever.

Threads—It has all threads in daily use with simple movement of lever.

Carriage—The carriage reverses in Apron. No slamming of Countershaft. There is no comparison between this Lathe and the old style or common Lathe. Quick work, rapid changes, satisfactory results. BUY THE BEST.

SEND FOR CIRCULAR.

THE HENDEY MACHINE CO.

TORRINGTON, CONN.

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Hine & Robertson Co., New York.
Hoppes Mfg. Co., Springfield, O.
National Pipe Bending Co., New Haven, Conn.
Taunton Locomotive Mfg. Co., Taunton, Mass.

Files.
Besly & Co., Chas. H., Chicago, Ill.
Montgomery & Co., New York.
Nicholson File Co., Providence, R. I.
Strelinger & Co., Chas. A., Detroit, Mich.

Flexible Tubing.
Almond, T. R., Brooklyn, N. Y.

Friction Cones.
Evans Friction Cone Co., Boston, Mass.

Furnaces.
American Gas Furnace Co., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.

Gages.
Brown & Sharpe Mfg. Co., Providence, R. I.
Coffin & Leighton, Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Taylor-Rice Engineering Co., Gloucester City, N. J.

Gear Cutters.
Brainard Milling Machine Co., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Grant, Geo. B., Lexington, Mass.
Gould & Eberhardt, Newark, N. J.
Hill, Clarke & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whiton Machine Co., D. E., New London, Conn.

Gears.
Bilgram Hugo, Philadelphia, Pa.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Grant, Geo. B., Lexington, Mass.
New Process Raw Hide Co., Syracuse, N. Y.
Shriver & Co., T., New York.

Graphite.
Dixon Crucible Co., Joseph, Jersey City, N. J.

Grinders, Center.
Barker & Co., William, Cincinnati, O.
Leland & Faulconer Mfg. Co., Detroit, Mich.
Trump Bros. Machine Co., Wilmington, Del.

Grinding Machines, Universal.
Brown & Sharpe Mfg. Co., Providence, R. I.
Landis Bros., Waynesboro, Pa.

Grinding and Polishing Machines.
Besly & Co., Chas. H., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Garvin Machine Co., New York.
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Landis Bros., Waynesboro, Pa.
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Place Machine Co., George, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Strelinger & Co., Chas. A., Detroit, Mich.

Grinding Machine, Cutter.
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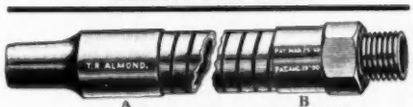

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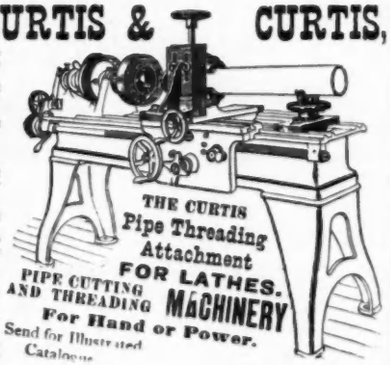
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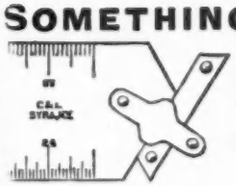

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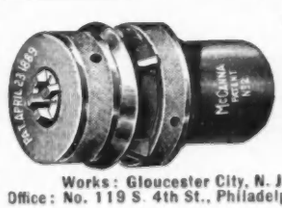

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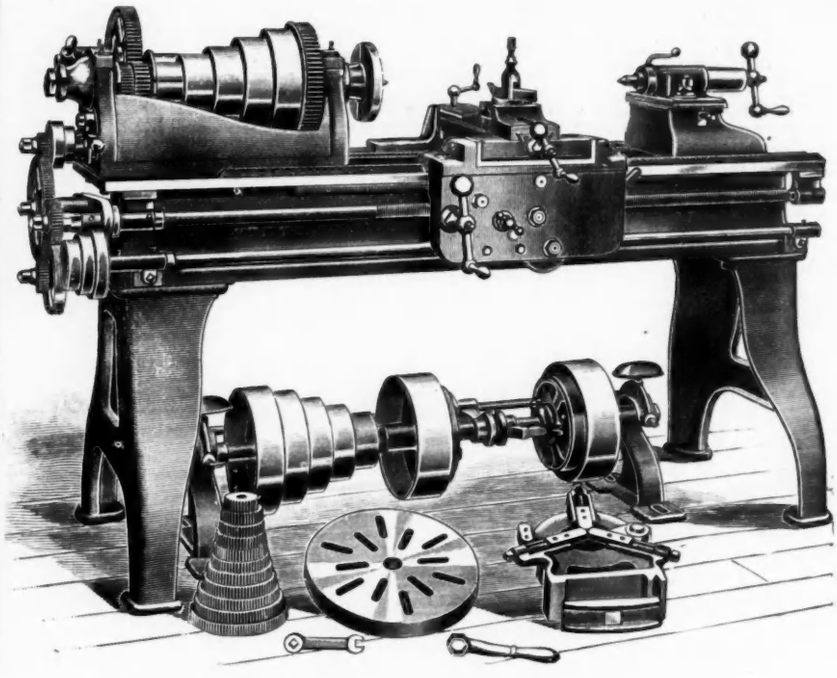

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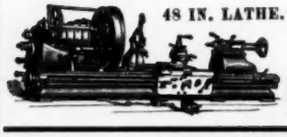

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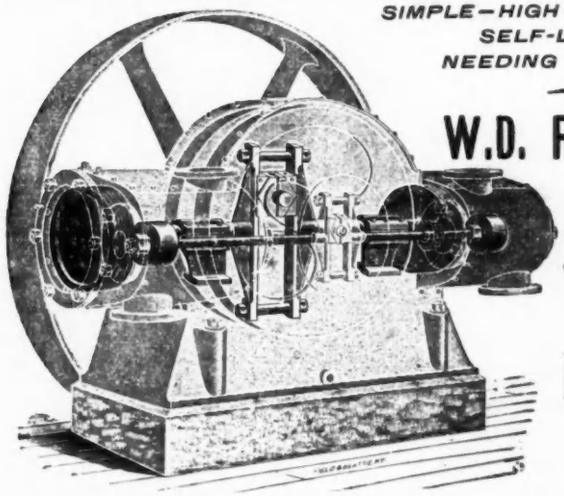

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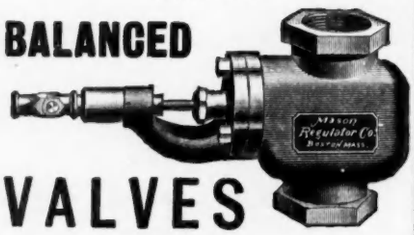

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